JACKSONVILLE HARBOR DEEPENING STUDY

ECOLOGICAL MODELING PRELIMINARY RESULTS

Steven Schropp, Ph.D., Taylor Engineering, Inc.
David Stiles, Ph.D., Taylor Engineering, Inc.

October 22, 2012

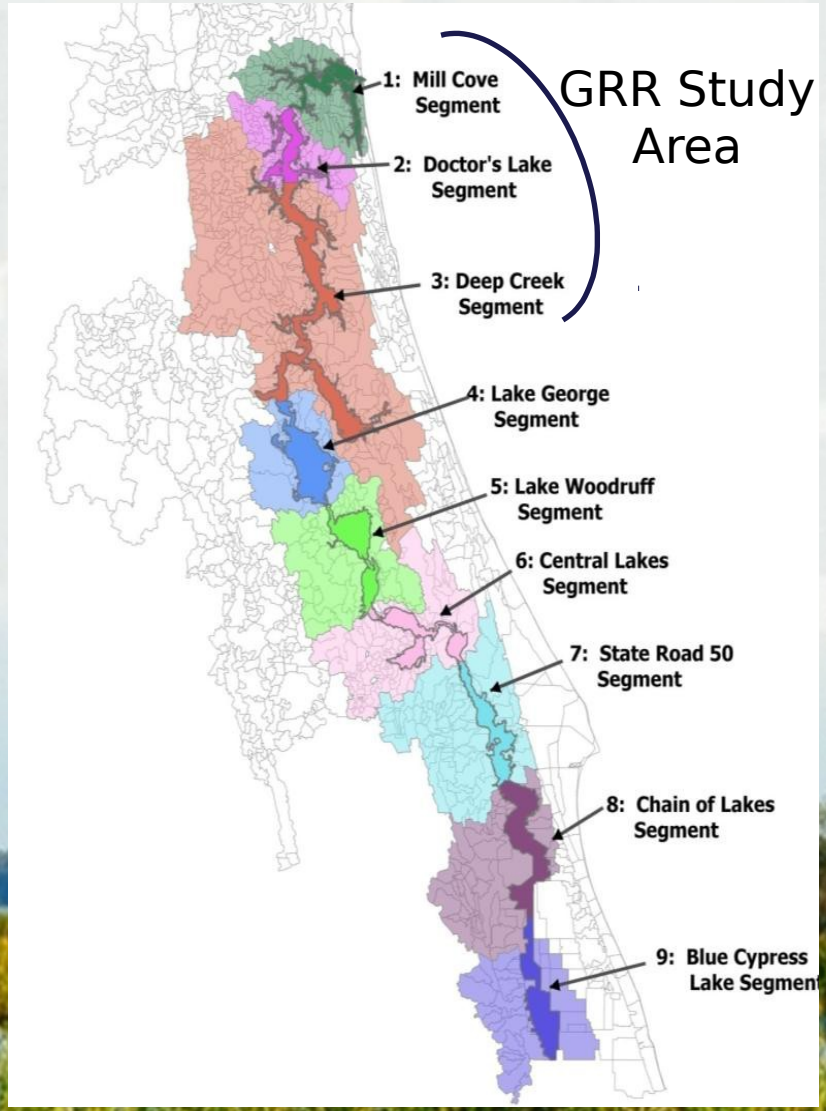
ECOLOGICAL MODELING OVERVIEW

Study Area

- River mouth to Lake George
- Lower part of river subject to salinity change

Ecological Models

- Wetland vegetation
- Submerged aquatic vegetation
- Benthic macroinvertebrates
- Fish
- Plankton



WETLAND VEGETATION MODEL

Evaluation Topic

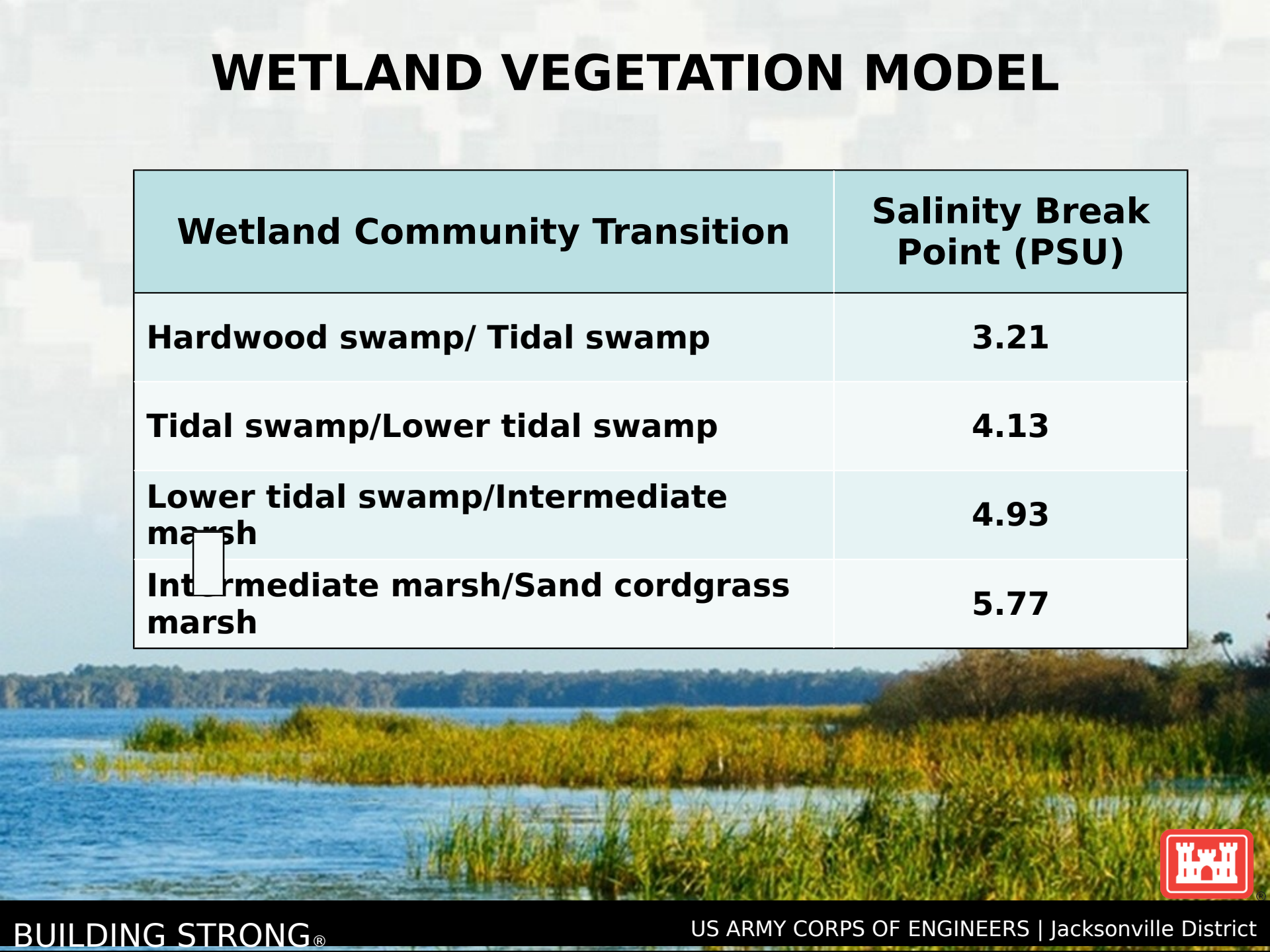
- Marsh community shifts due to salinity change

Evaluation Method

- Average salinity for 6-yr simulation period
- Vertical average of littoral cells
- Marsh boundaries defined by salinity “break points”
- Modeled salinity movement predicts community boundary and areal change

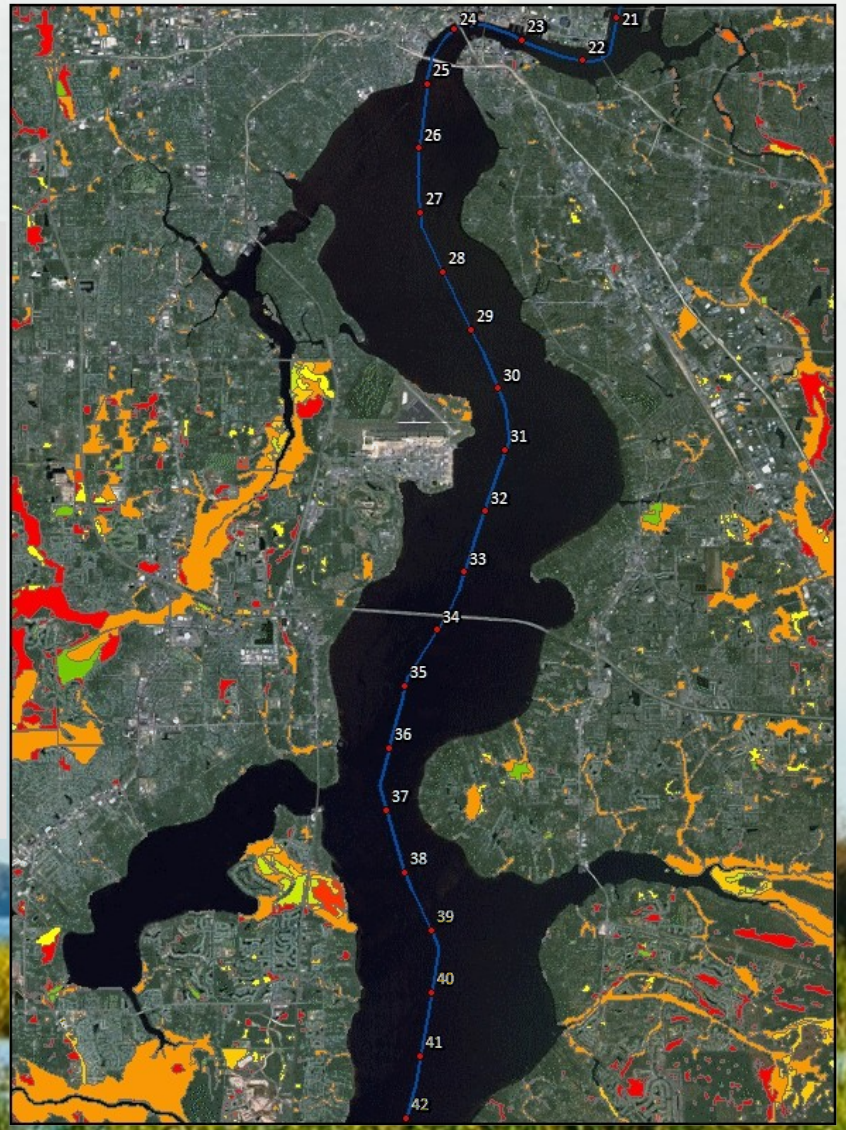
WETLAND VEGETATION MODEL

Wetland Community Transition	Salinity Break Point (PSU)
Hardwood swamp/ Tidal swamp	3.21
Tidal swamp/Lower tidal swamp	4.13
Lower tidal swamp/Intermediate marsh	4.93
Intermediate marsh/Sand cordgrass marsh	5.77



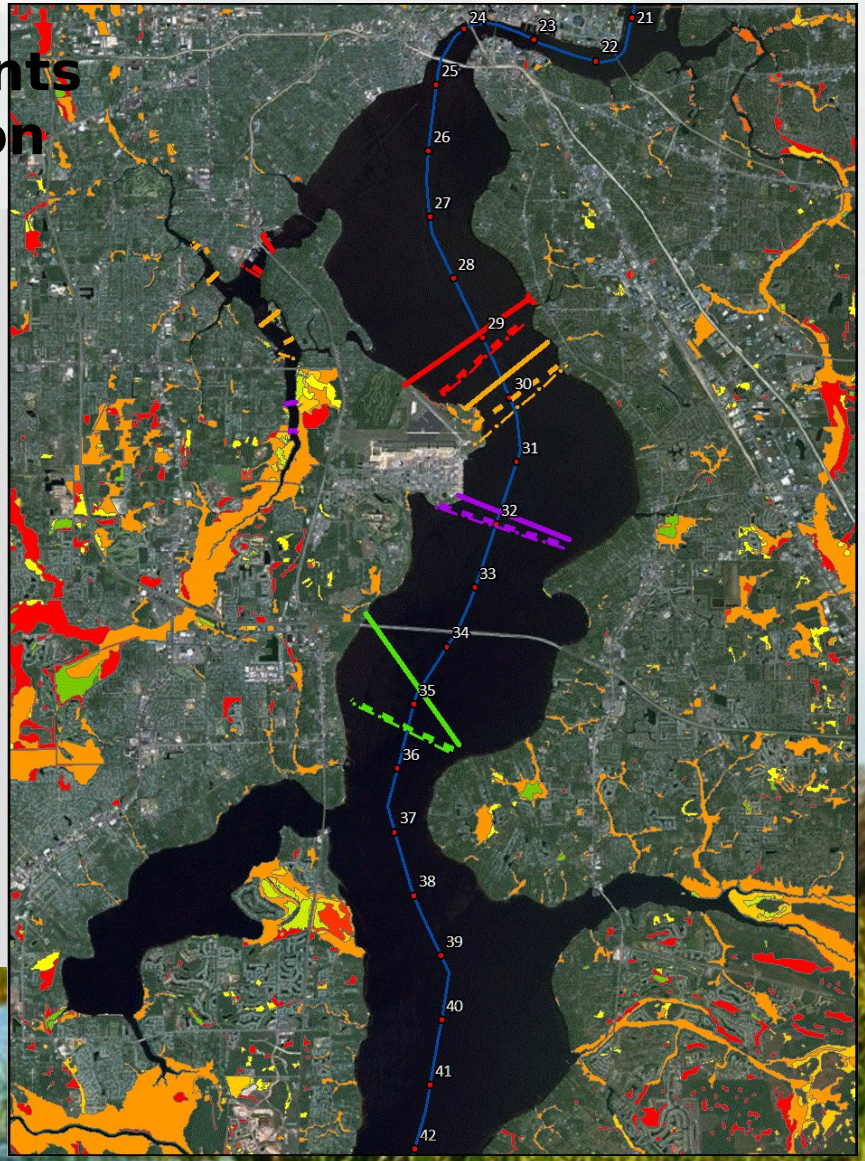
WETLAND VEGETATION MODEL

Wetland Areas



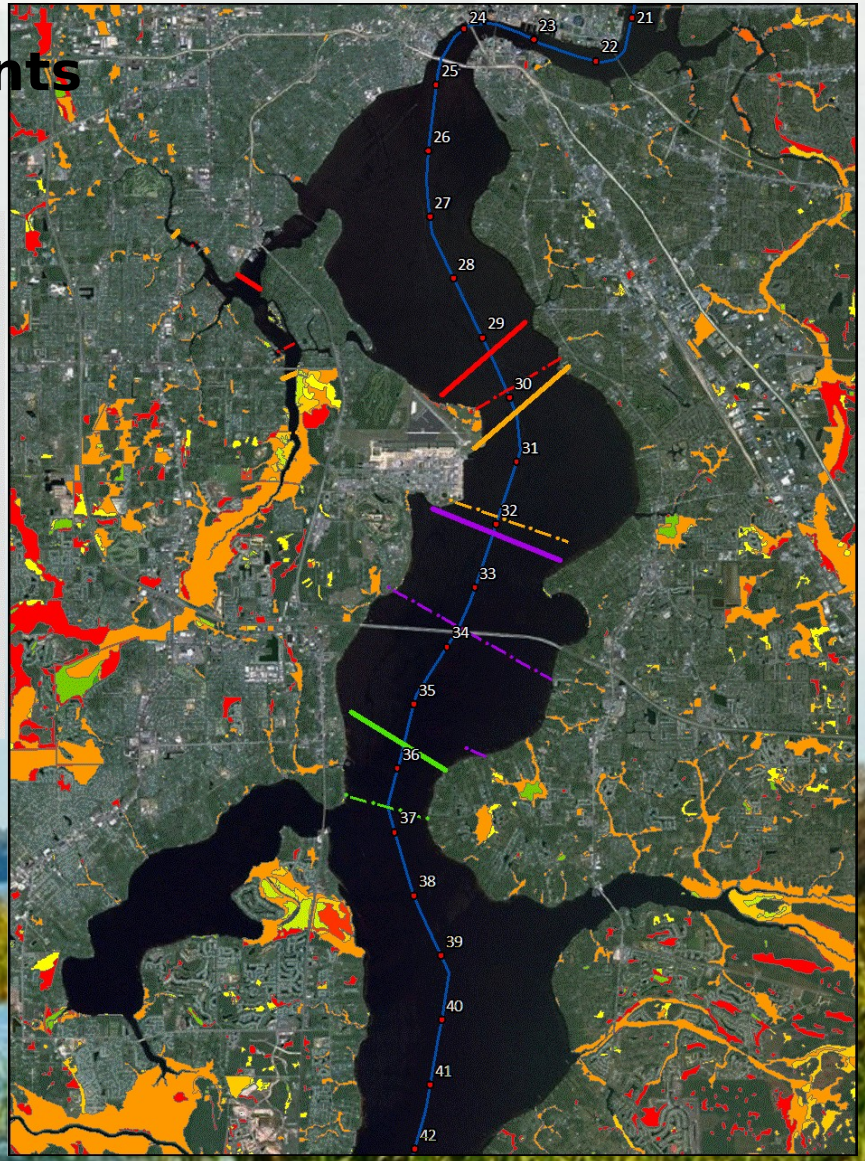
WETLAND VEGETATION MODEL

Salinity Breakpoints Current Condition



WETLAND VEGETATION MODEL

Salinity Breakpoints
50-yr Horizon



WETLAND VEGETATION MODEL

		Distance (Miles) Upstream From Baseline			Distance (Miles) Upstream from 50-yr Baseline	
Wetland Community	Salinity Break Point (PSU)	46 ft	50 ft	Baseline + 50 yr	50 yr Base + 46 ft	50 yr Base + 50 ft
Freshwater swamp/ Freshwater tidal swamp	3.21	0.56	0.62	0.83	0.90	0.98
Freshwater tidal swamp/ Lower tidal swamp	4.13	0.18	0.23	0.34	1.09	1.51
Lower tidal swamp/ Intermediate marsh	4.93	0.33	0.51	0.54	1.59	1.65
Intermediate Marsh/ Sand cordgrass marsh	5.77	0.30	0.36	0.34	0.49	0.62

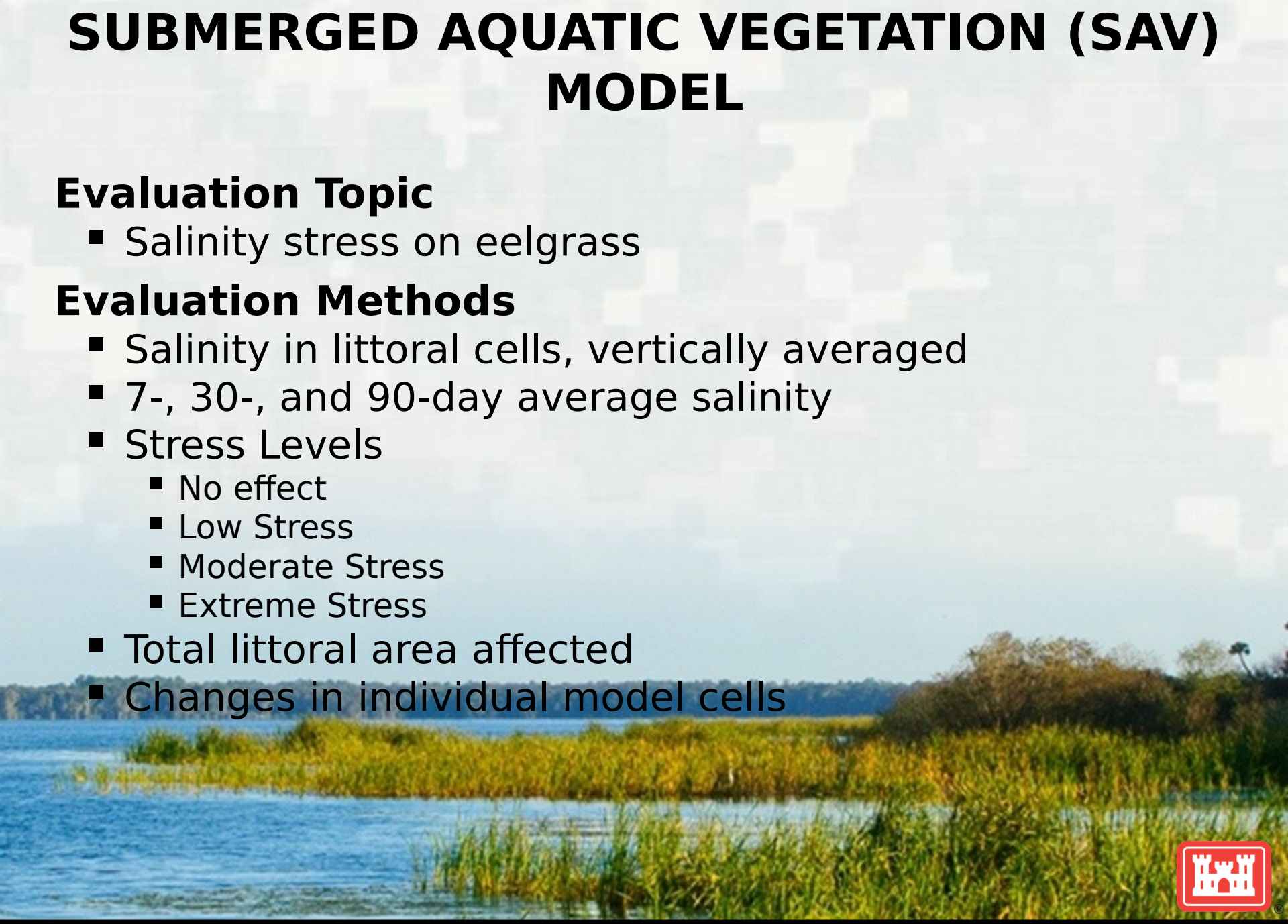
SUBMERGED AQUATIC VEGETATION (SAV) MODEL

Evaluation Topic

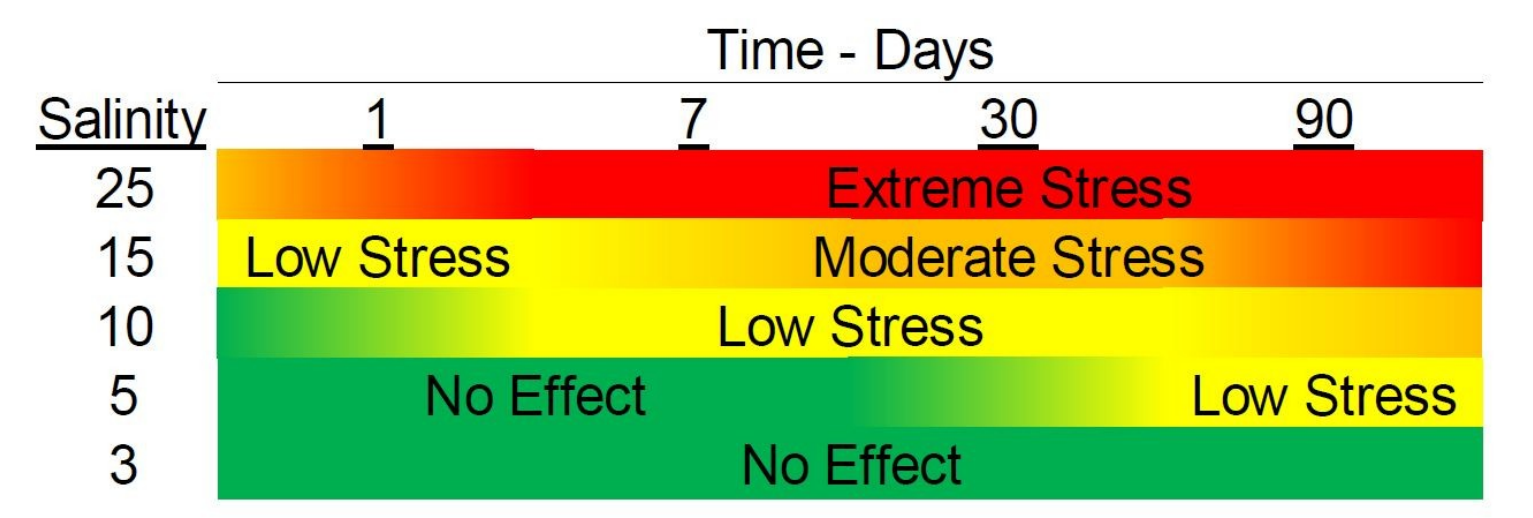
- Salinity stress on eelgrass

Evaluation Methods

- Salinity in littoral cells, vertically averaged
- 7-, 30-, and 90-day average salinity
- Stress Levels
  - No effect
  - Low Stress
  - Moderate Stress
  - Extreme Stress
- Total littoral area affected
- Changes in individual model cells



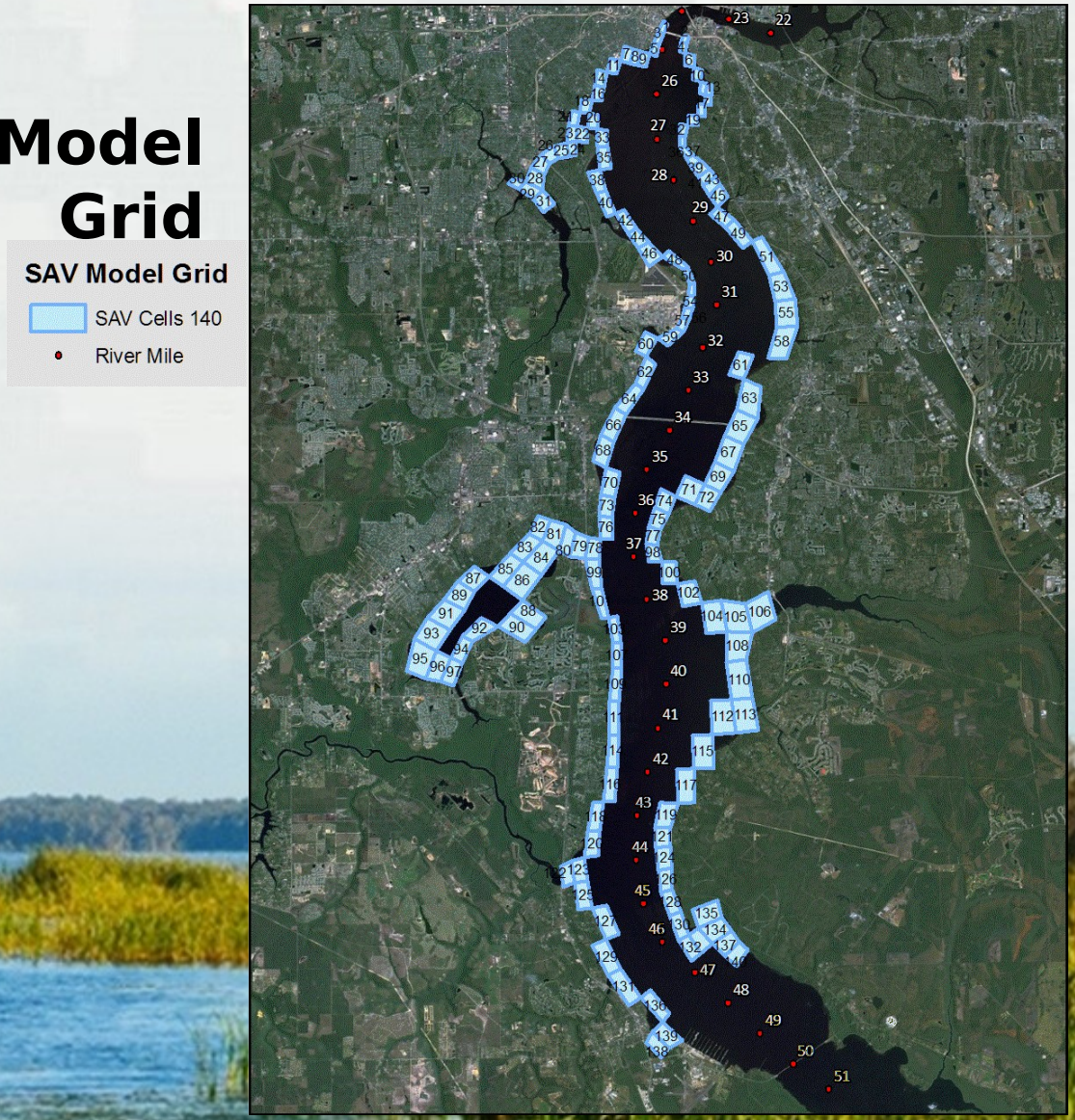
SUBMERGED AQUATIC VEGETATION (SAV) MODEL



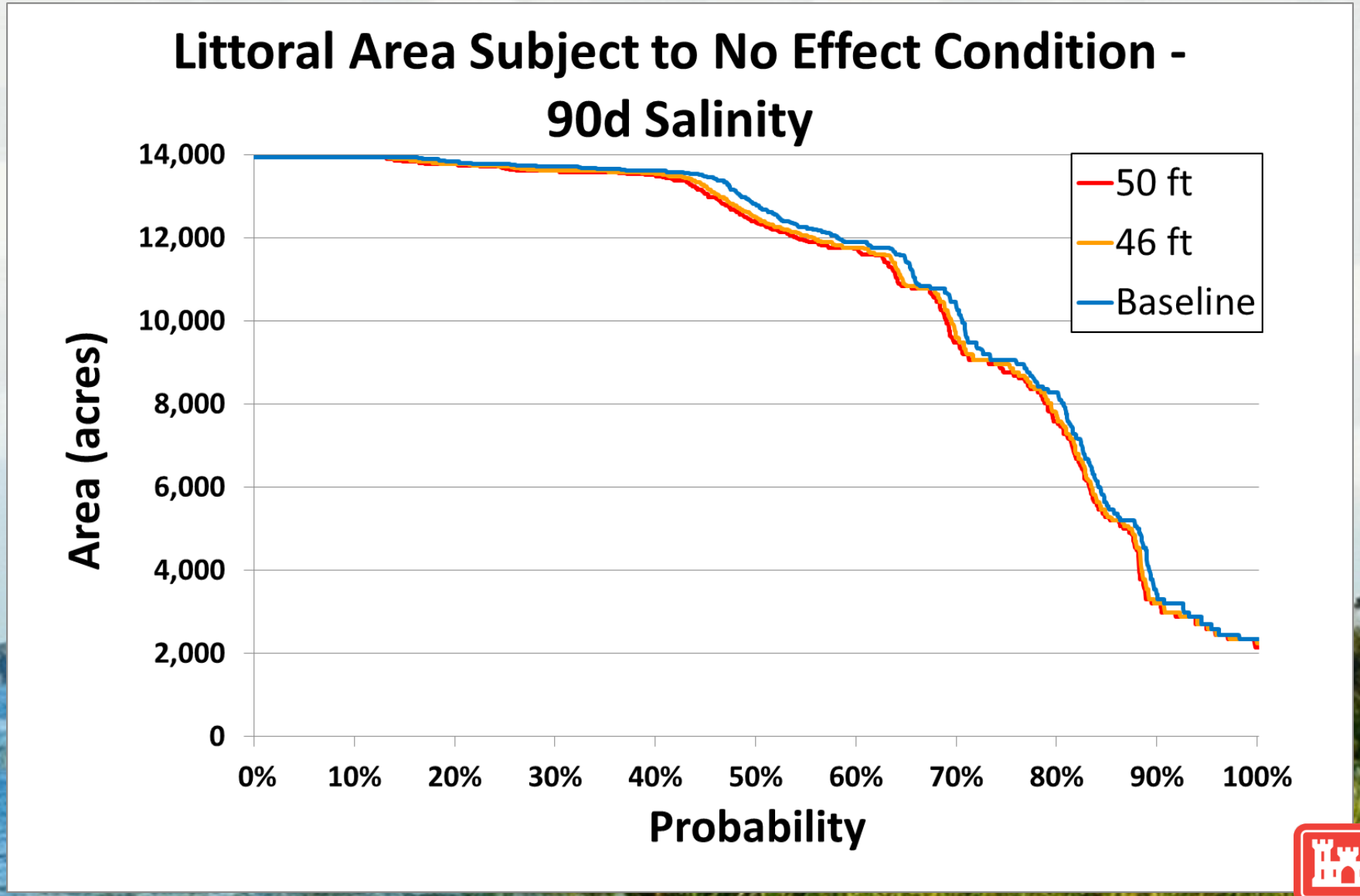
Source: SJRWMD WSIS Final Report

SUBMERGED AQUATIC VEGETATION (SAV) MODEL

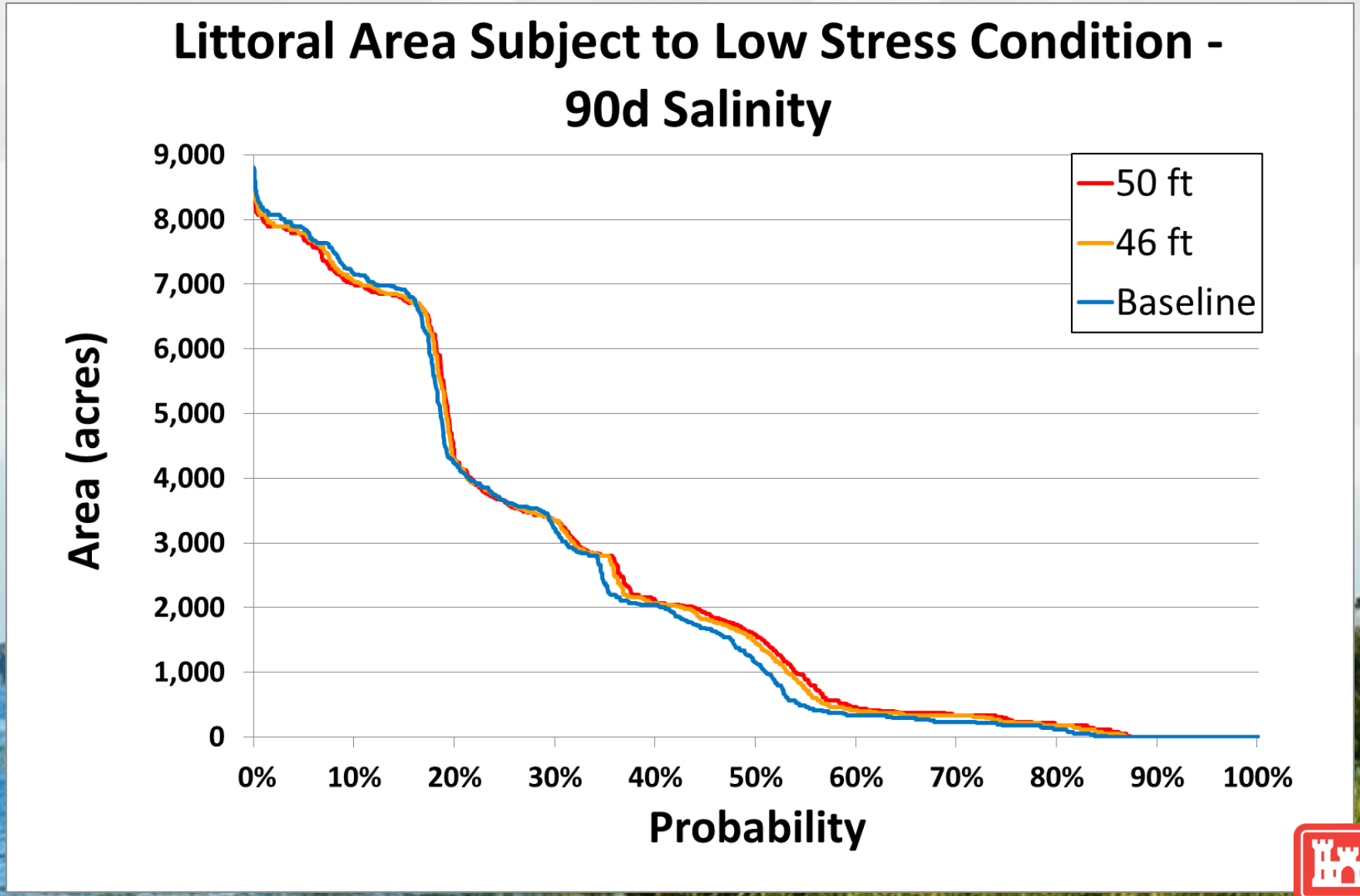
SAV Model Grid



SUBMERGED AQUATIC VEGETATION (SAV) MODEL

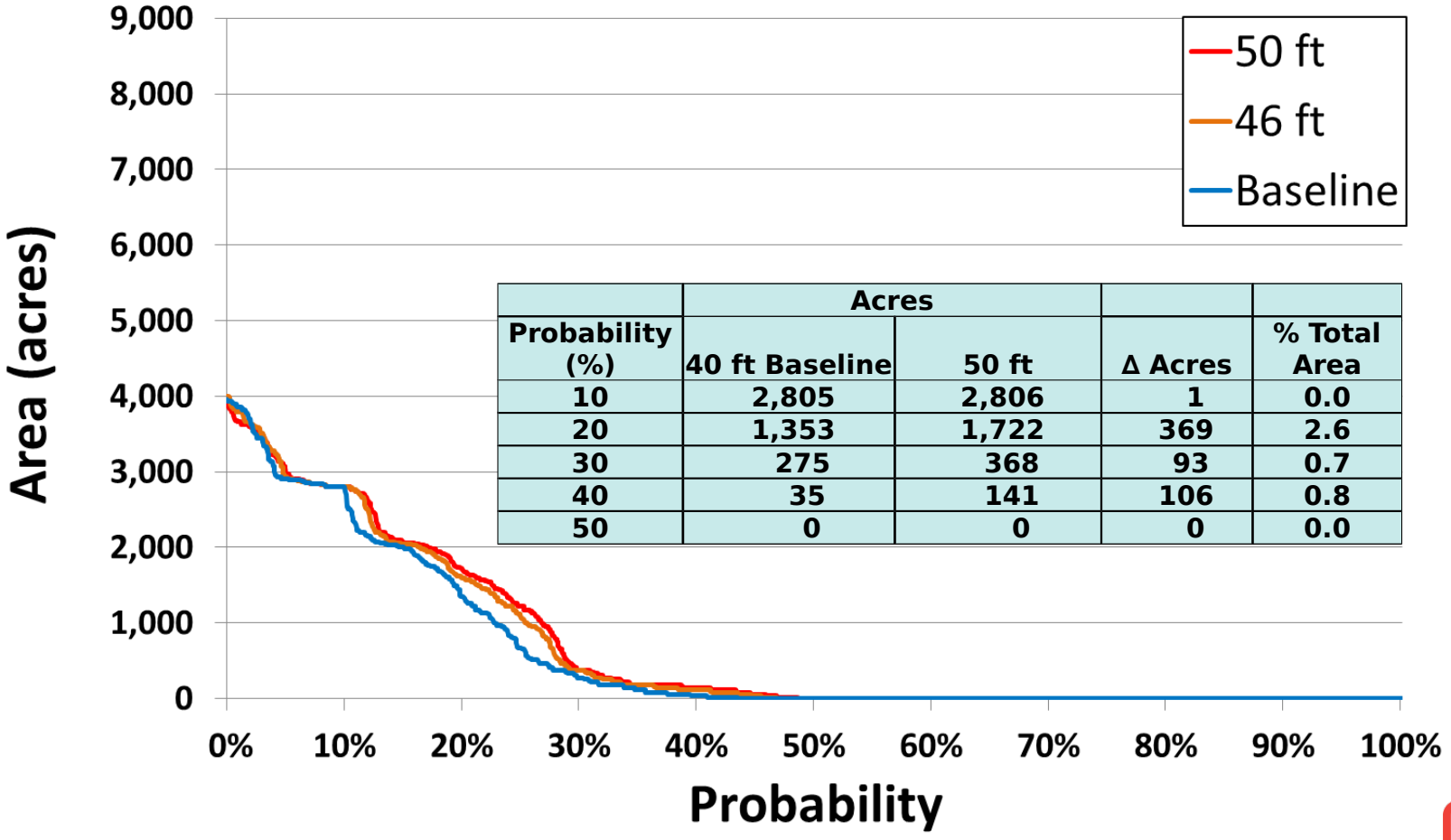


SUBMERGED AQUATIC VEGETATION (SAV) MODEL



SUBMERGED AQUATIC VEGETATION (SAV) MODEL

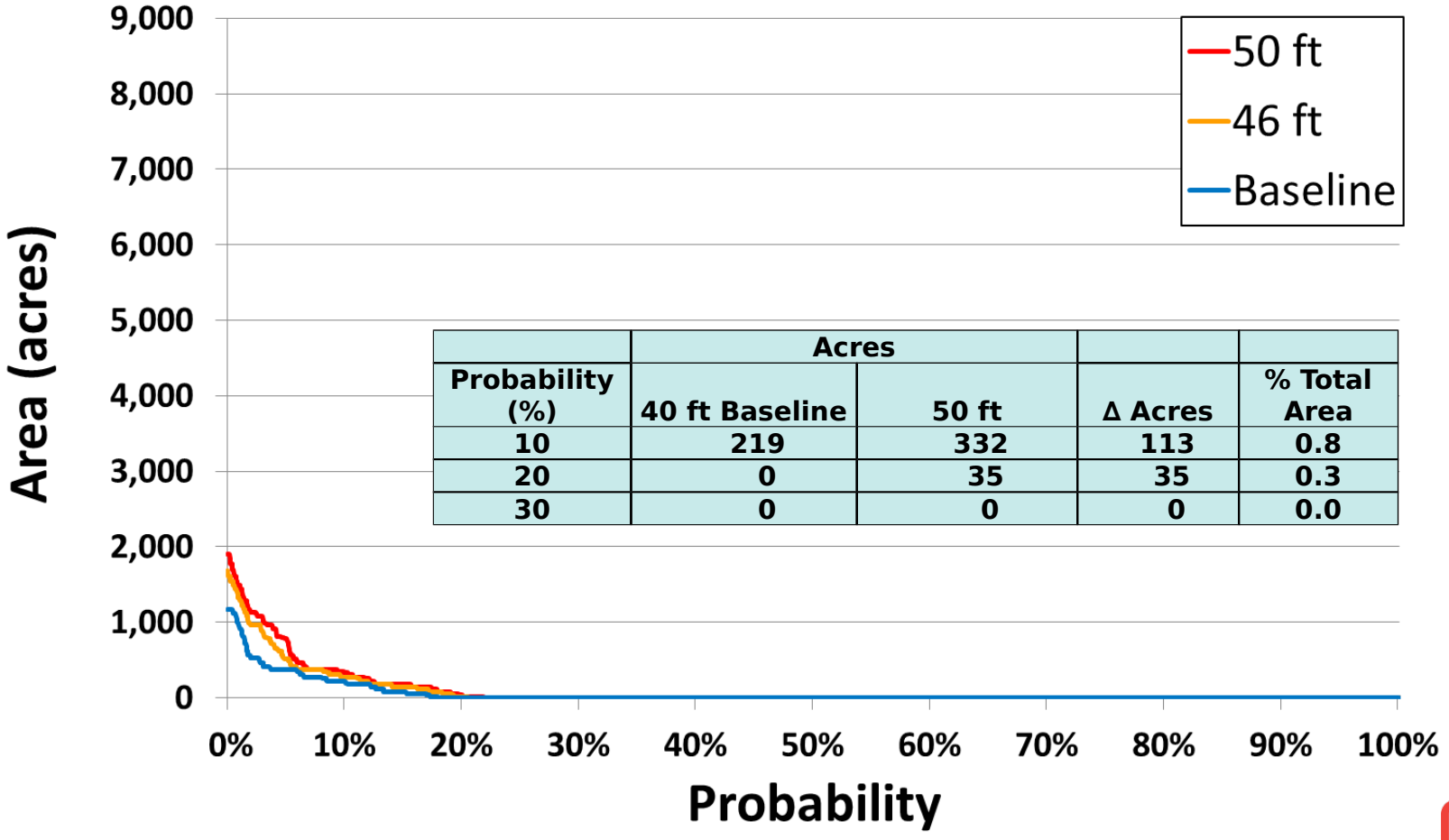
Littoral Area Subject to Moderate Stress Condition - 90d Salinity



	Acres			
Probability (%)	40 ft Baseline	50 ft	Δ Acres	% Total Area
10	2,805	2,806	1	0.0
20	1,353	1,722	369	2.6
30	275	368	93	0.7
40	35	141	106	0.8
50	0	0	0	0.0

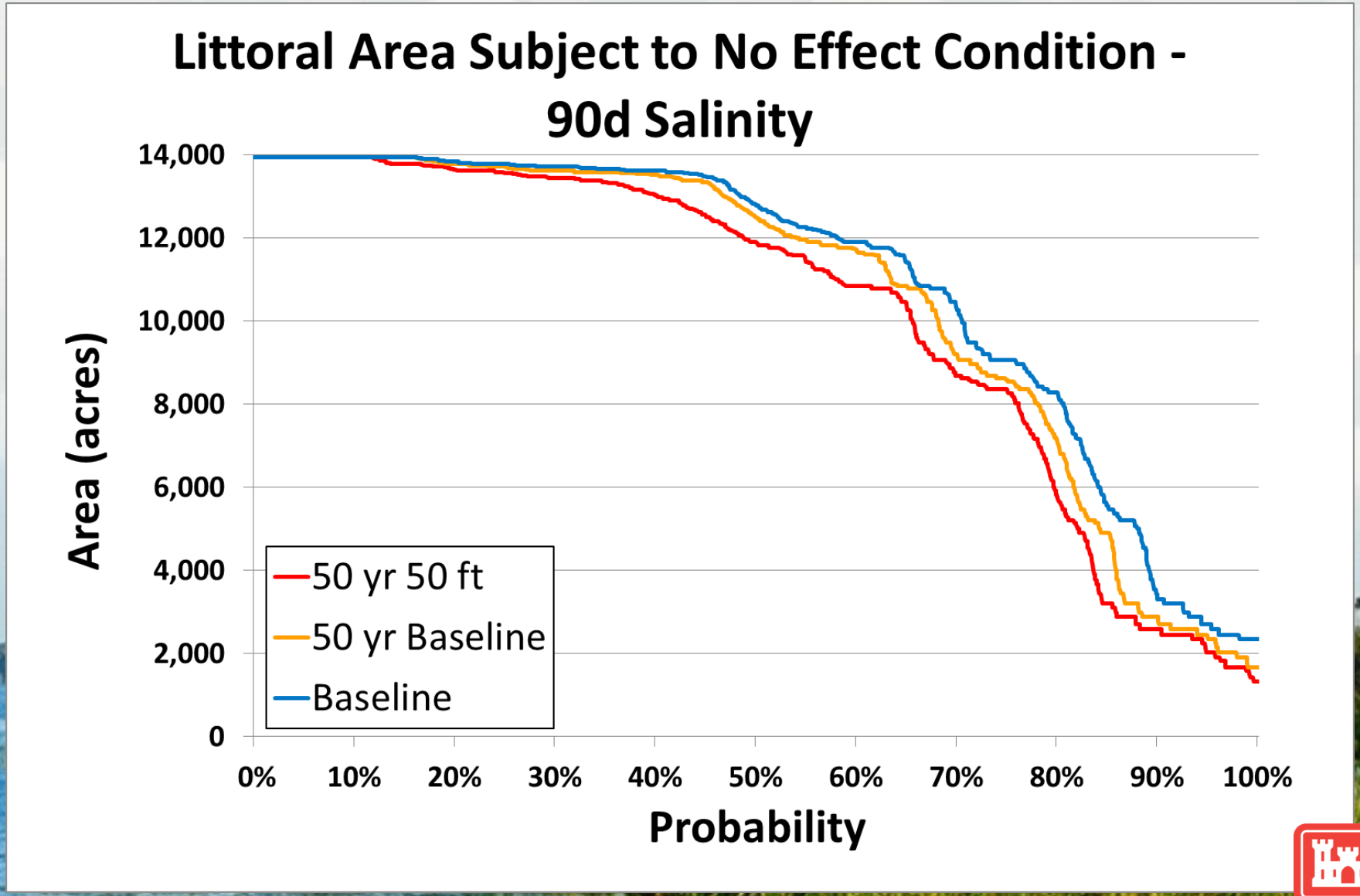
SUBMERGED AQUATIC VEGETATION (SAV) MODEL

Littoral Area Subject to Extreme Stress Condition - 90d Salinity

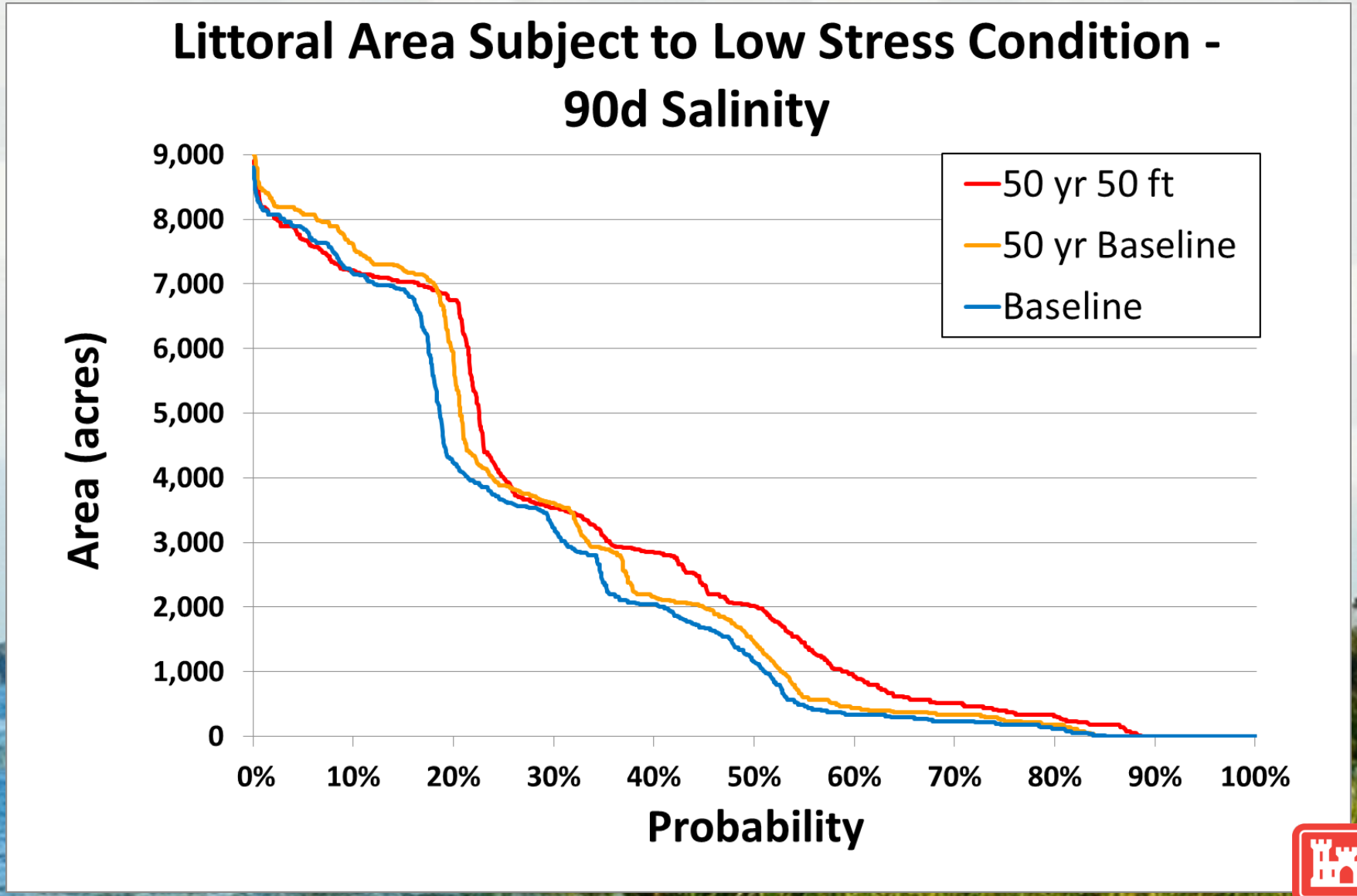


	Acres			
Probability (%)	40 ft Baseline	50 ft	Δ Acres	% Total Area
10	219	332	113	0.8
20	0	35	35	0.3
30	0	0	0	0.0

SUBMERGED AQUATIC VEGETATION (SAV) MODEL

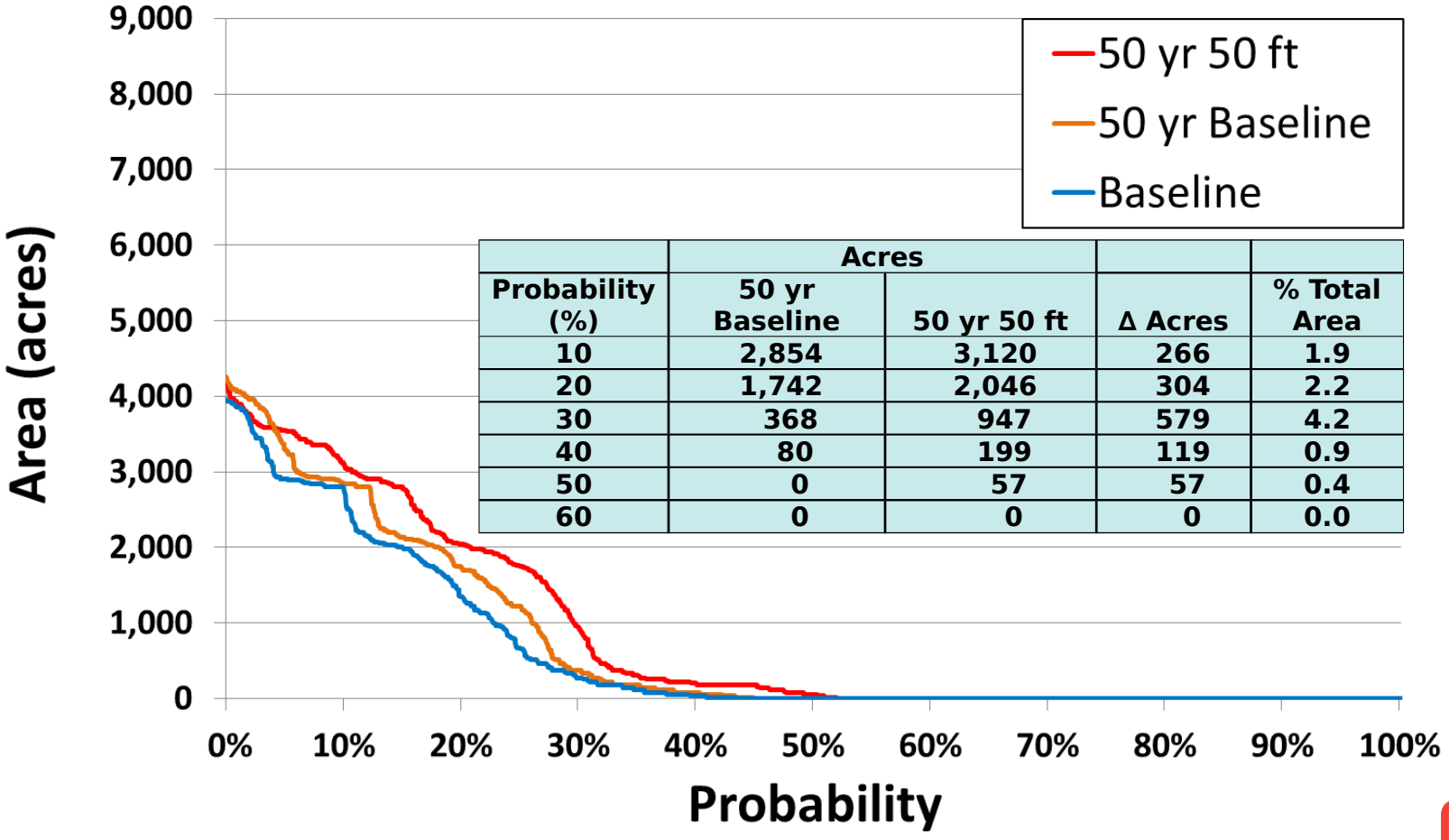


SUBMERGED AQUATIC VEGETATION (SAV) MODEL



SUBMERGED AQUATIC VEGETATION (SAV) MODEL

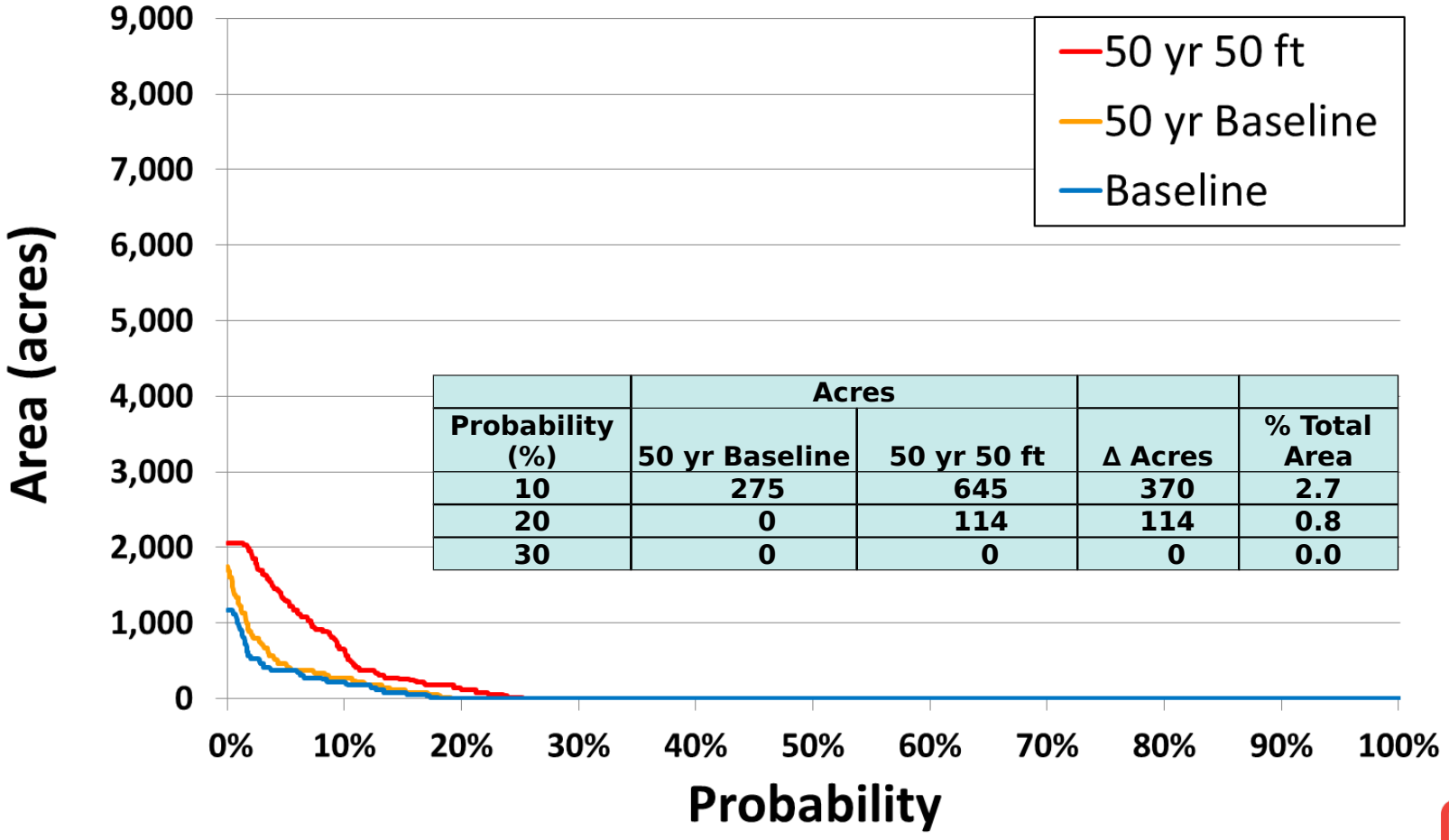
Littoral Area Subject to Moderate Stress Condition - 90d Salinity



	Acres			
Probability (%)	50 yr Baseline	50 yr 50 ft	Δ Acres	% Total Area
10	2,854	3,120	266	1.9
20	1,742	2,046	304	2.2
30	368	947	579	4.2
40	80	199	119	0.9
50	0	57	57	0.4
60	0	0	0	0.0

SUBMERGED AQUATIC VEGETATION (SAV) MODEL

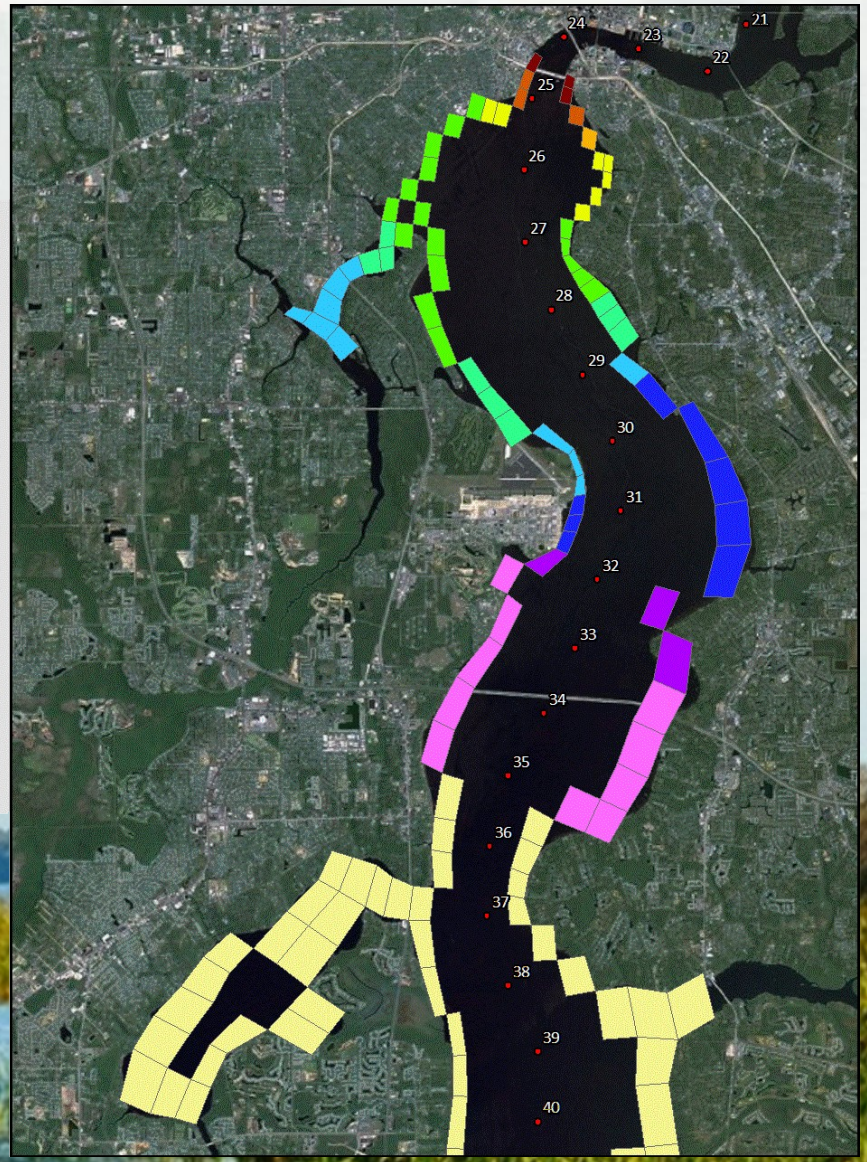
Littoral Area Subject to Extreme Stress Condition - 90d Salinity



	Acres			
Probability (%)	50 yr Baseline	50 yr 50 ft	Δ Acres	% Total Area
10	275	645	370	2.7
20	0	114	114	0.8
30	0	0	0	0.0

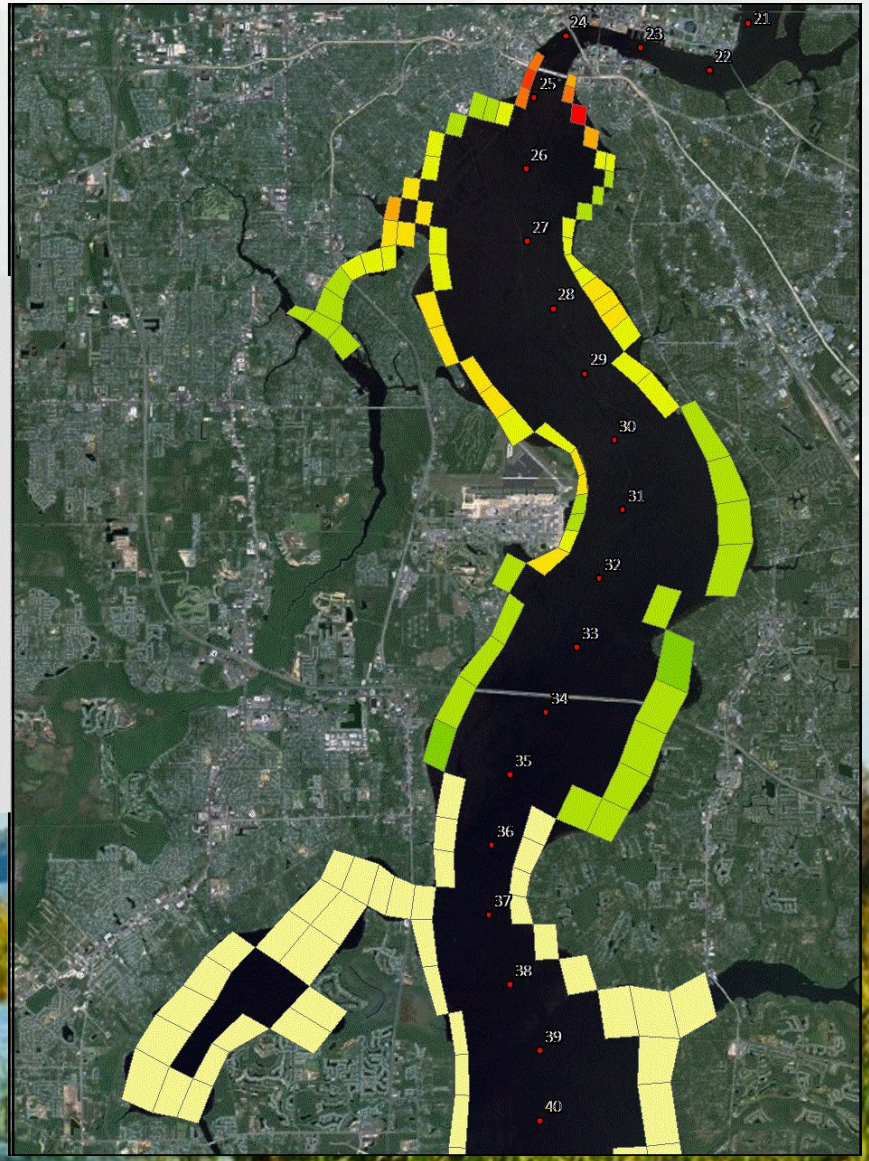
SUBMERGED AQUATIC VEGETATION (SAV) MODEL

Stress Frequency



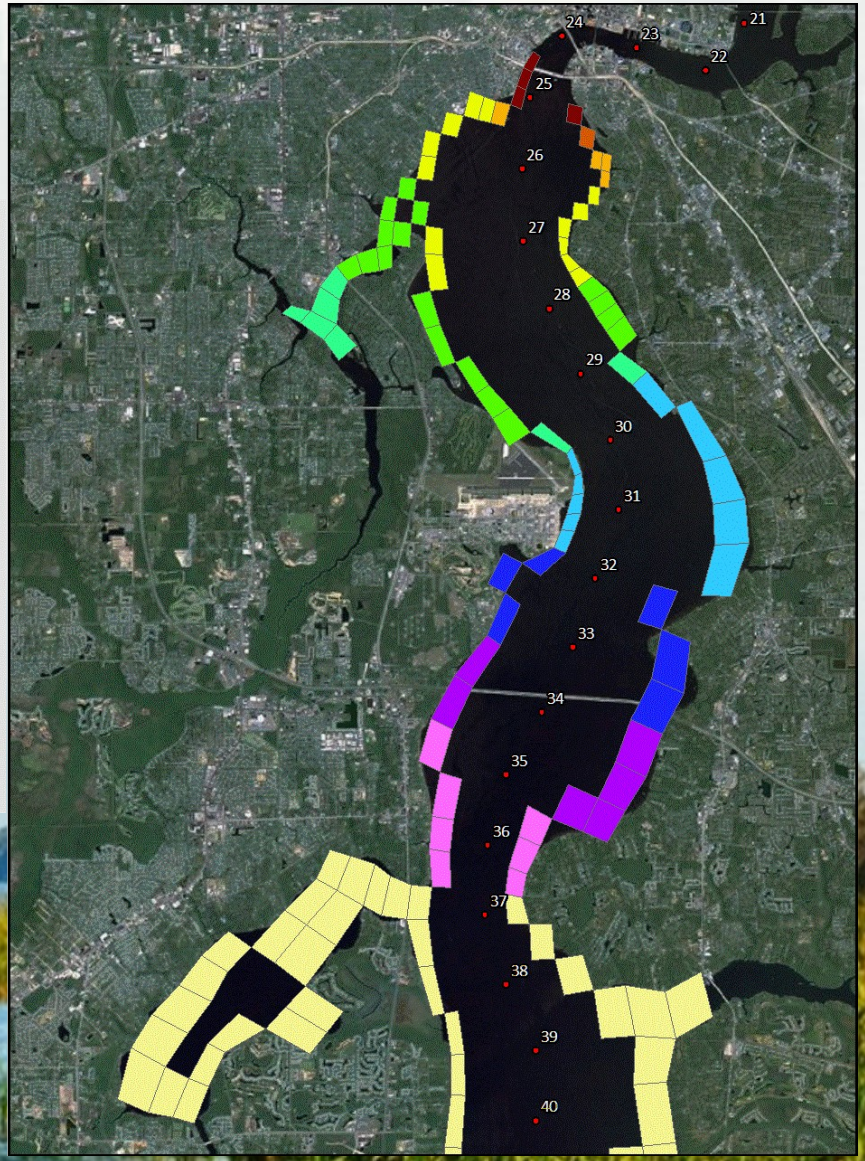
SUBMERGED AQUATIC VEGETATION (SAV) MODEL

Stress Increase



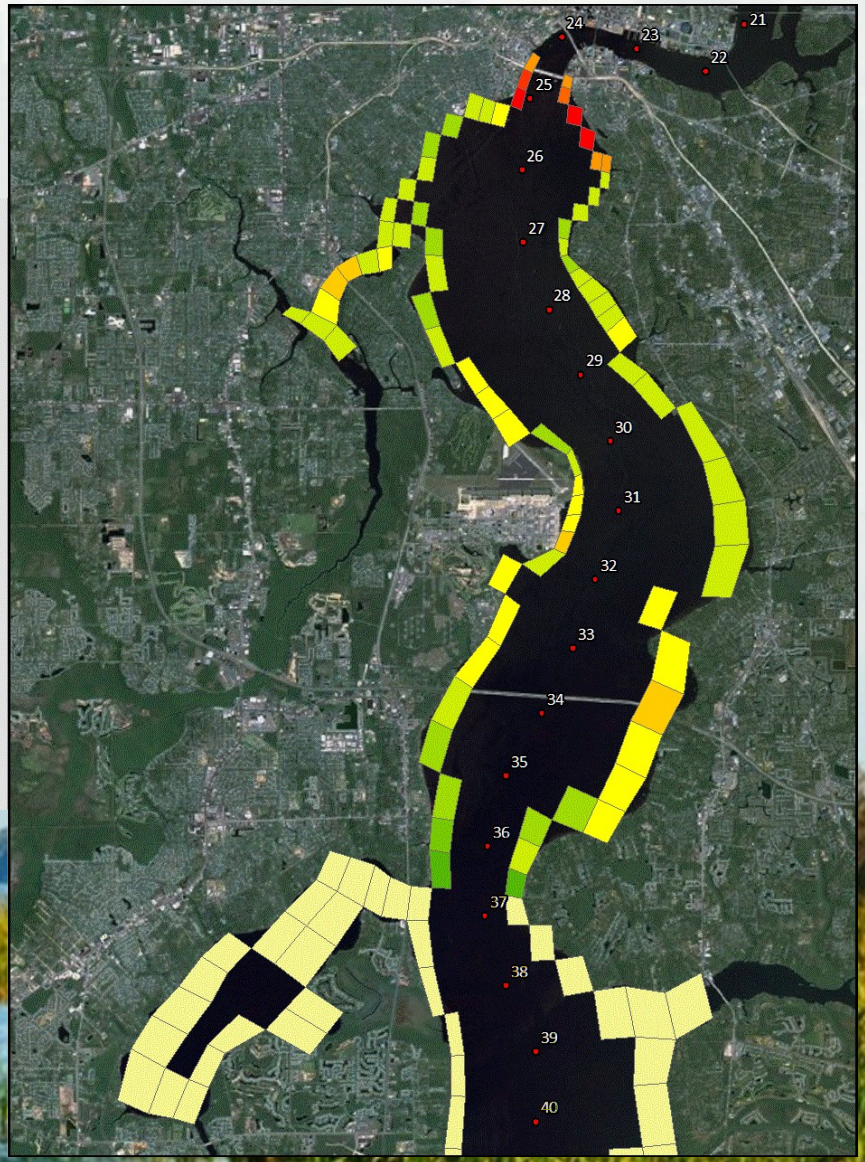
SUBMERGED AQUATIC VEGETATION (SAV) MODEL

50-yr Condition Stre Frequ



SUBMERGED AQUATIC VEGETATION (SAV) MODEL

50-yr Condition Sti Incr



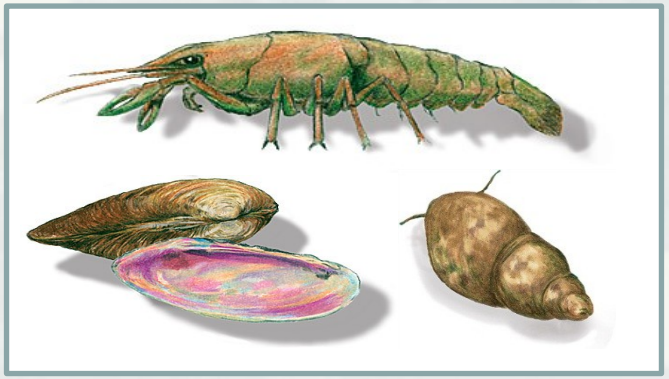
BENTHIC MACROINVERTEBRATE (BMI) MODEL

Evaluation Topic

- BMI Habitat Area

Effects Driver

- Salinity – extent and duration



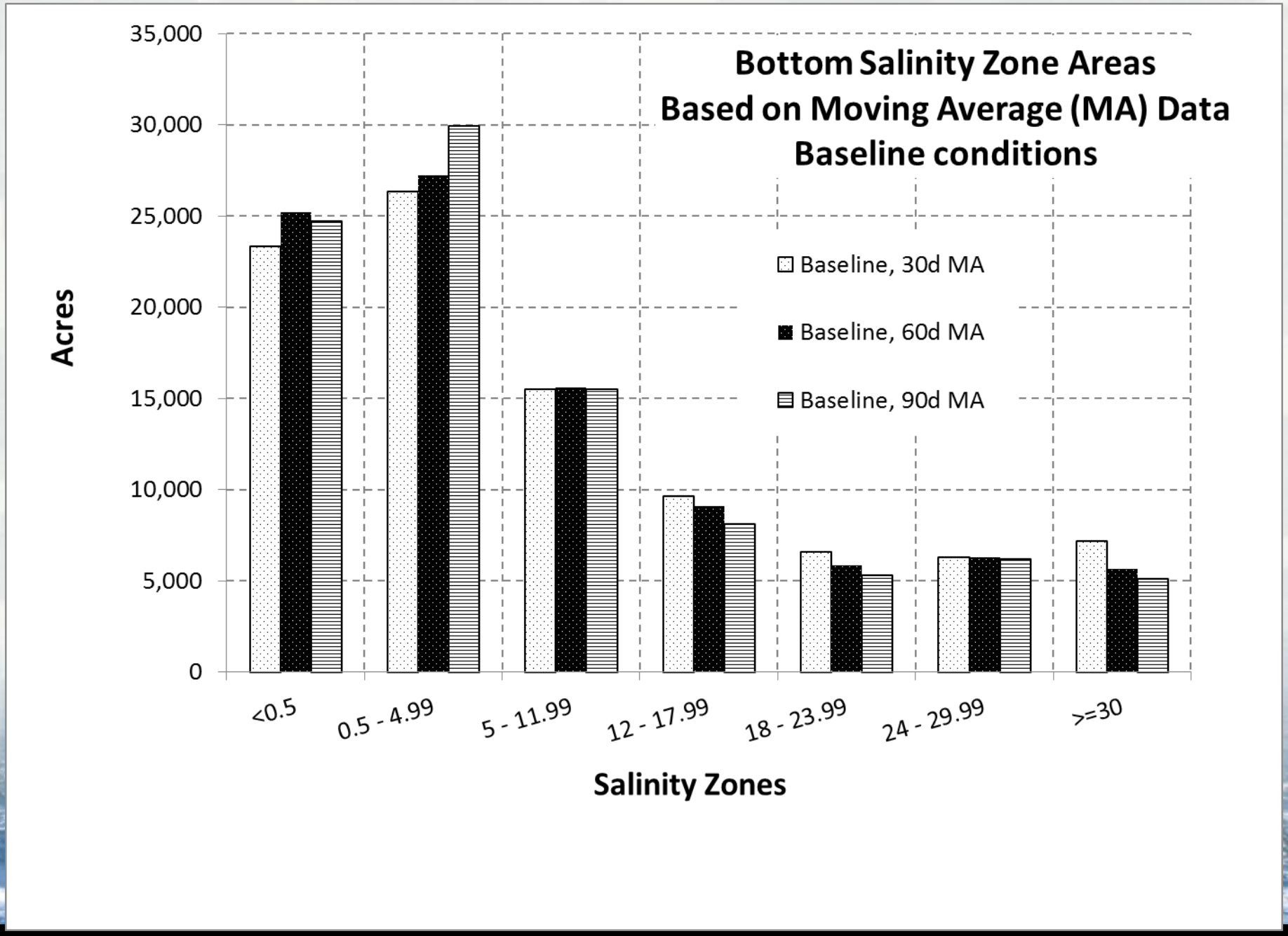
Evaluation Methods

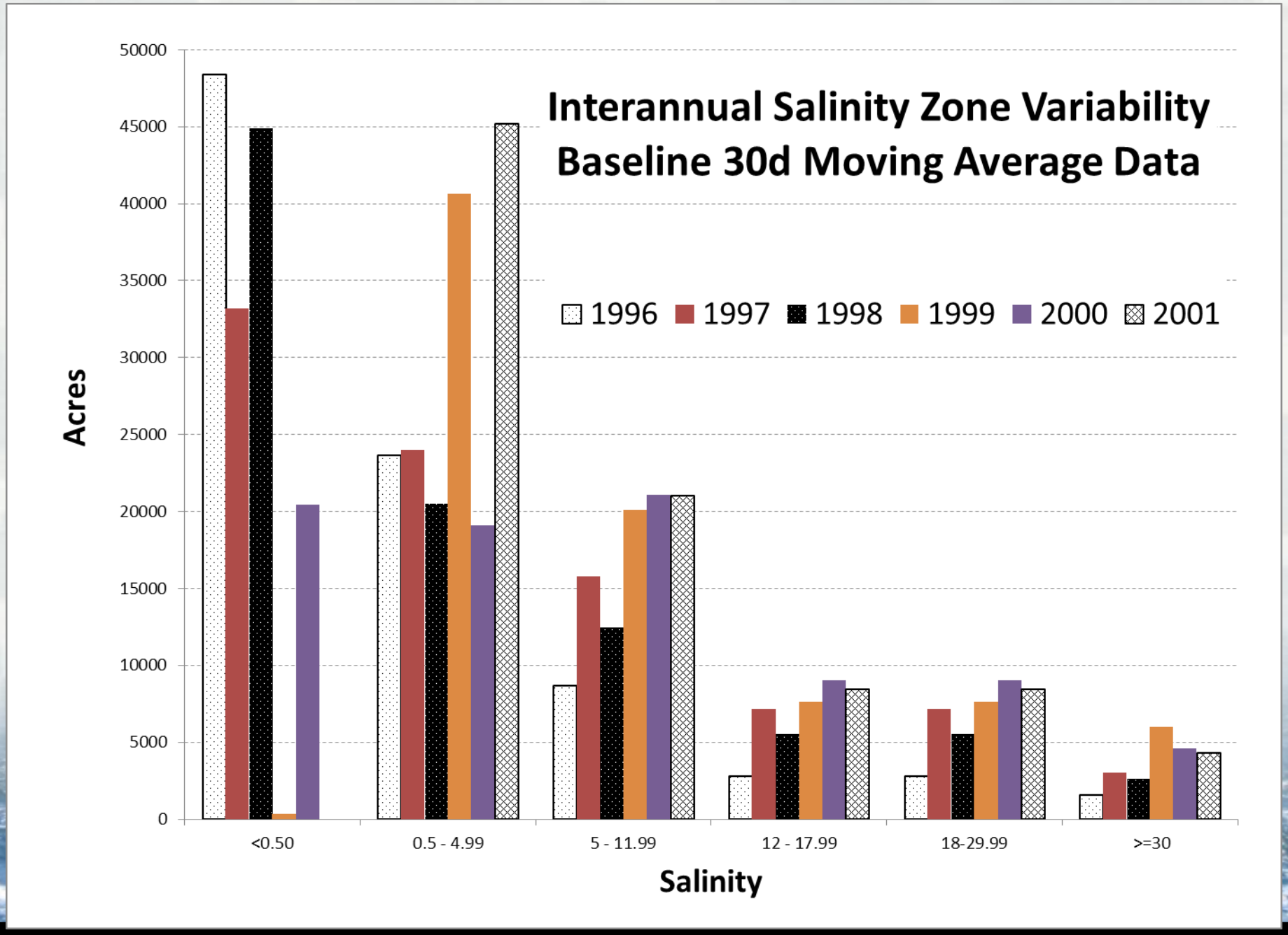
- Changes in area (acres) of each salinity category
- Analysis of changes in salinity duration at three river locations (Partial Duration Frequency analysis – PDFA)
- Regression model for total BMI abundance

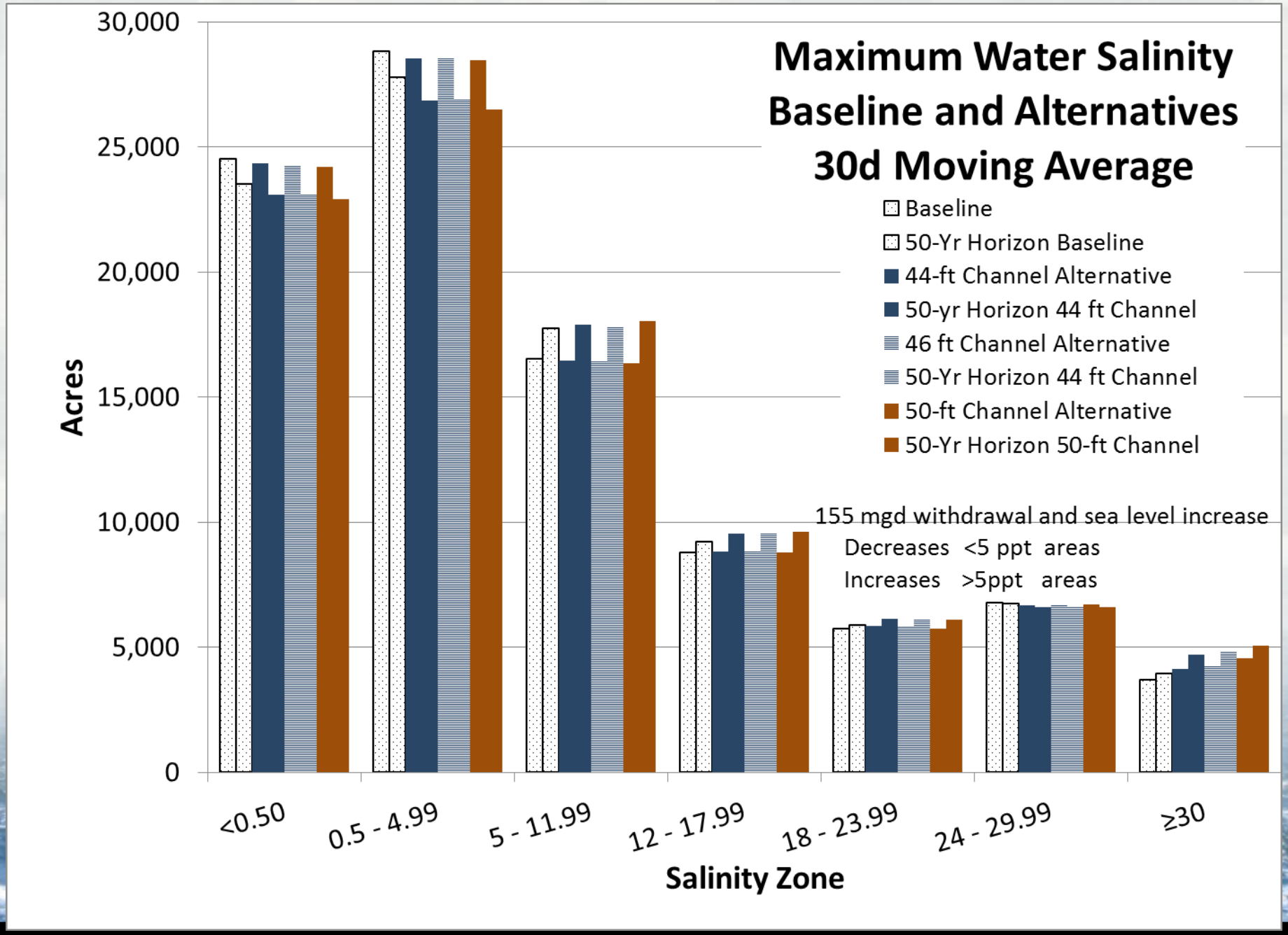
BENTHIC MACROINVERTEBRATE (BMI) MODEL

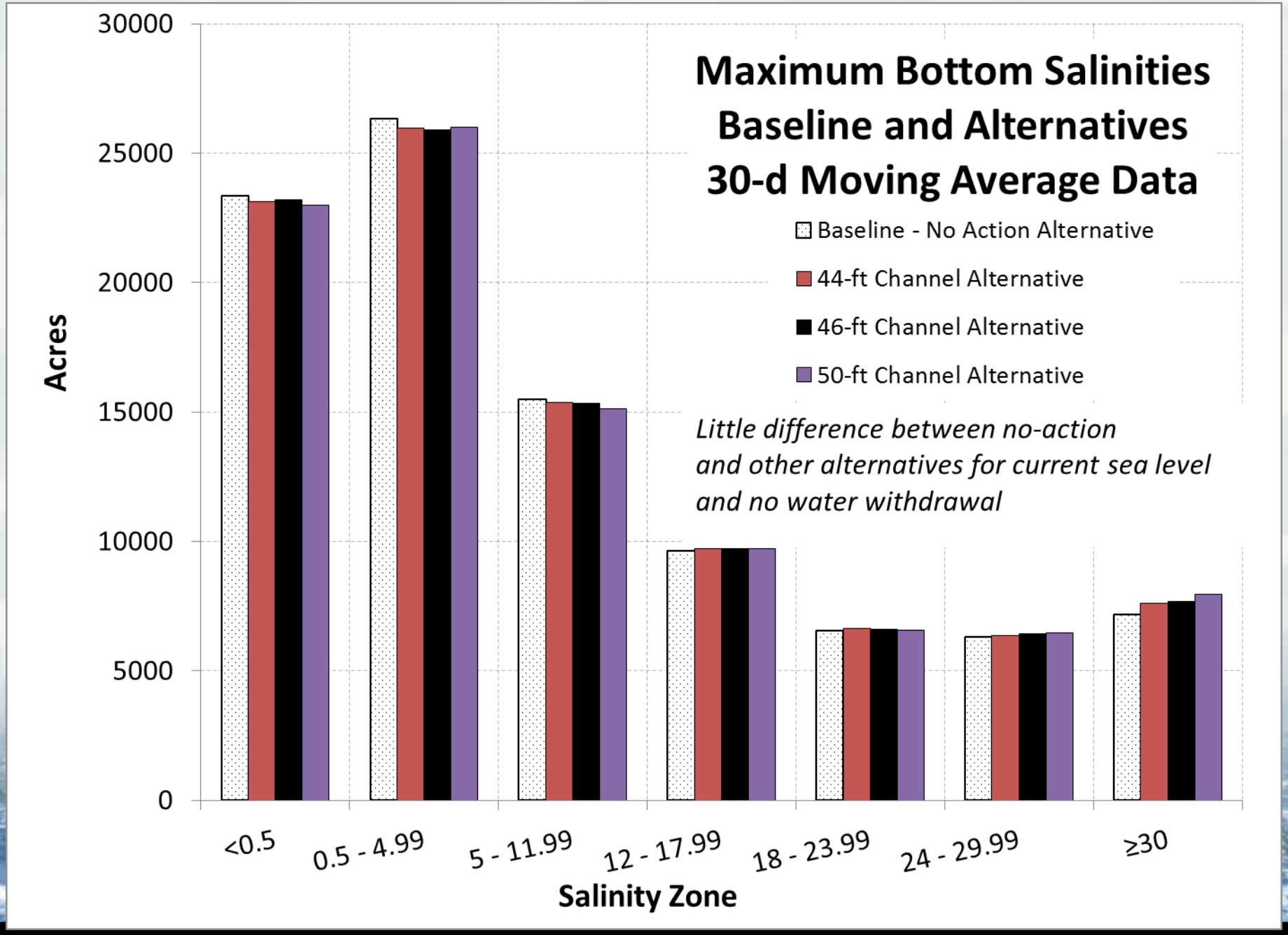
Results

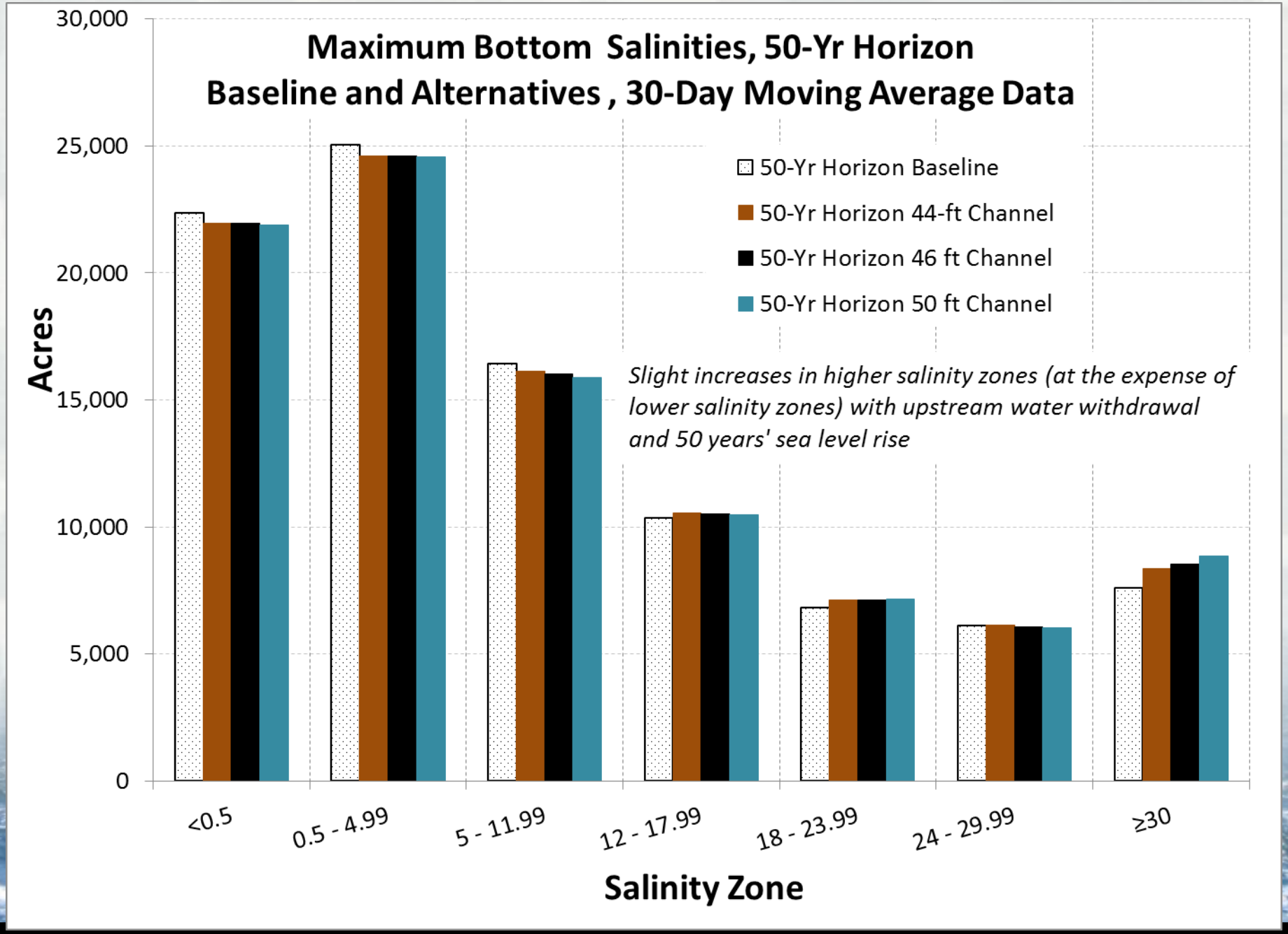
- Little change in total area of each salinity class
  - ≤ 0.5 ppt
  - 0.5 – 4.99 ppt
  - 5.0 – 11.99 ppt
  - 12.0 – 17.99 ppt
  - 18.0 ppt – 23.99 ppt
  - 24.0 ppt – 29.99 ppt
  - ≥ 30.0 ppt
- Changes with 50 years of sea level rise and 155 mgd water withdrawal far exceed effects of different channel depths
- Salinity zone locations show much smaller upstream shift than inter-annual variations
- Variations in “elevated “ salinity durations occur primarily between Fuller Warren Bridge and Shands Bridge

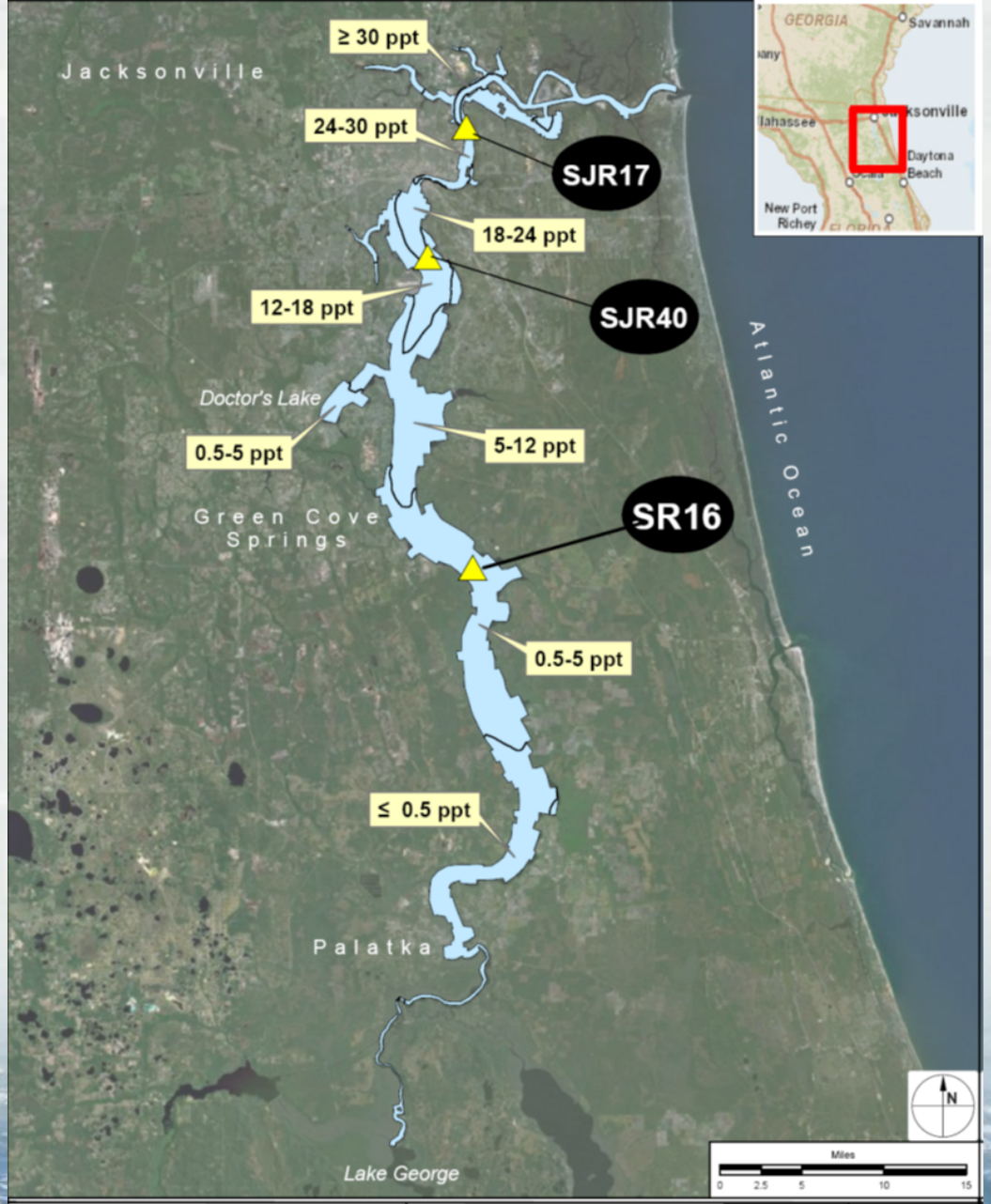

Bottom Salinity Zone Areas
Based on Moving Average (MA) Data
Baseline conditions
Baseline, 30d MA
Baseline, 60d MA
Baseline, 90d MA
Acres
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
<0.5
0.5 - 4.99
5 - 11.99
12 - 17.99
18 - 23.99
24 - 29.99
>=30
Salinity Zones


Interannual Salinity Zone Variability
Baseline 30d Moving Average Data
1996
1997
1998
1999
2000
2001
Acres
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
<0.50
0.5 - 4.99
5 - 11.99
12 - 17.99
18-29.99
>=30
Salinity


Maximum Water Salinity
Baseline and Alternatives
30d Moving Average
Baseline
50-Yr Horizon Baseline
44-ft Channel Alternative
50-yr Horizon 44 ft Channel
46 ft Channel Alternative
50-Yr Horizon 44 ft Channel
50-ft Channel Alternative
50-Yr Horizon 50-ft Channel
155 mgd withdrawal and sea level increase
Decreases <5 ppt areas
Increases >5ppt areas
Acres
30,000
25,000
20,000
15,000
10,000
5,000
0
<0.50
0.5 - 4.99
5 - 11.99
12 - 17.99
18 - 23.99
24 - 29.99
≥30
Salinity Zone


Maximum Bottom Salinities
Baseline and Alternatives
30-d Moving Average Data
Baseline - No Action Alternative
44-ft Channel Alternative
46-ft Channel Alternative
50-ft Channel Alternative
Little difference between no-action and other alternatives for current sea level and no water withdrawal
Acres
30000
25000
20000
15000
10000
5000
0
<0.5
0.5 - 4.99
5 - 11.99
12 - 17.99
18 - 23.99
24 - 29.99
≥30
Salinity Zone

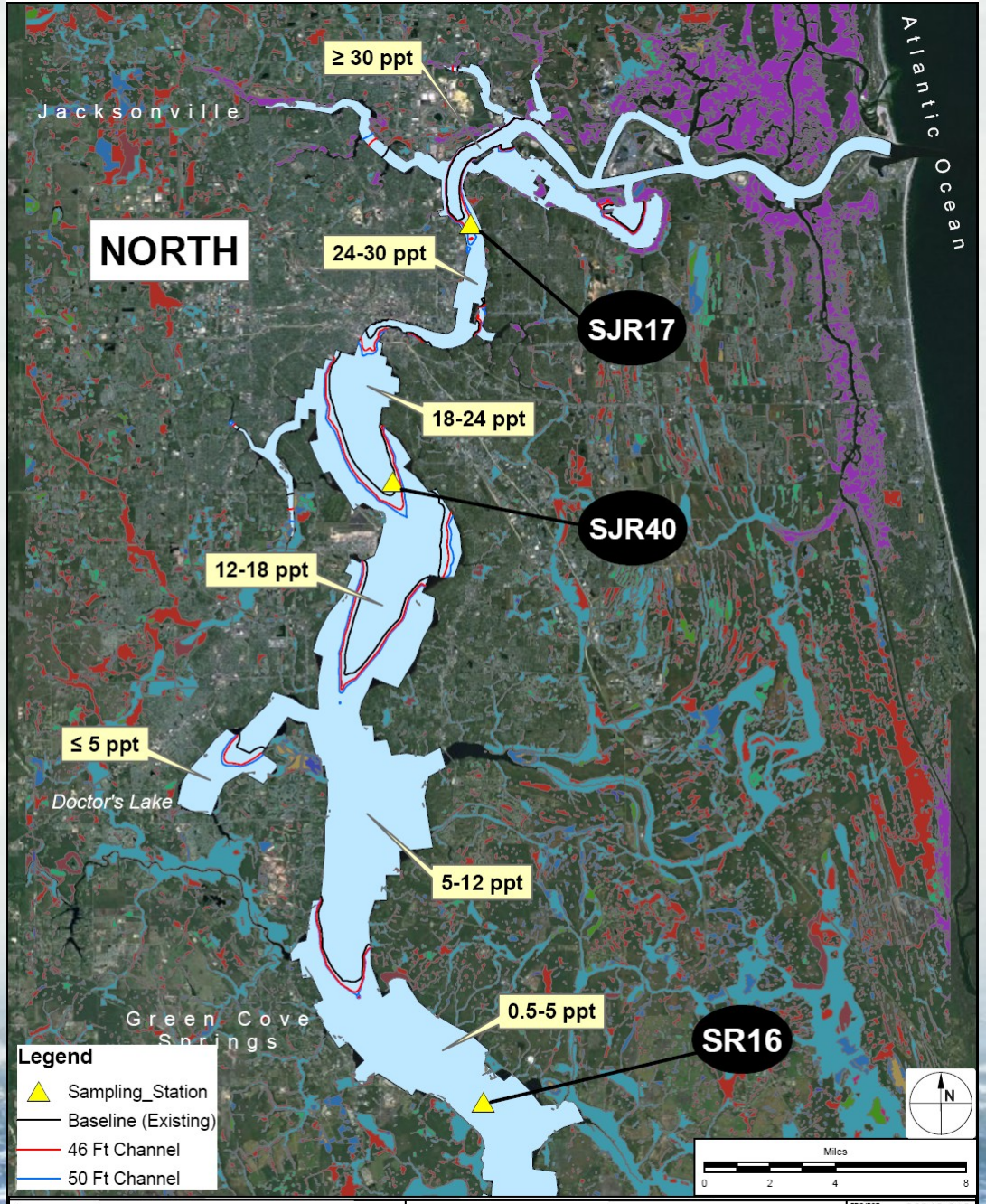

Maximum Bottom Salinities, 50-Yr Horizon
Baseline and Alternatives , 30-Day Moving Average Data
30,000
25,000
20,000
15,000
10,000
5,000
0
Acres
50-Yr Horizon Baseline
50-Yr Horizon 44-ft Channel
50-Yr Horizon 46 ft Channel
50-Yr Horizon 50 ft Channel
Slight increases in higher salinity zones (at the expense of lower salinity zones) with upstream water withdrawal and 50 years' sea level rise
<0.5
0.5 - 4.99
5 - 11.99
12 - 17.99
18 - 23.99
24 - 29.99
≥30
Salinity Zone



Taylor Engineering Inc.
10151 Deerwood Park Blvd.
Bldg. 300, Suite 300
Jacksonville, FL 32256
CERTIFICATE OF AUTHORIZATION # 4615

Maximum Bottom Salinity
30 Day Moving Average
Existing Condition (Baseline)
USACE Ecological Modeling for Jax Harbor Deepening

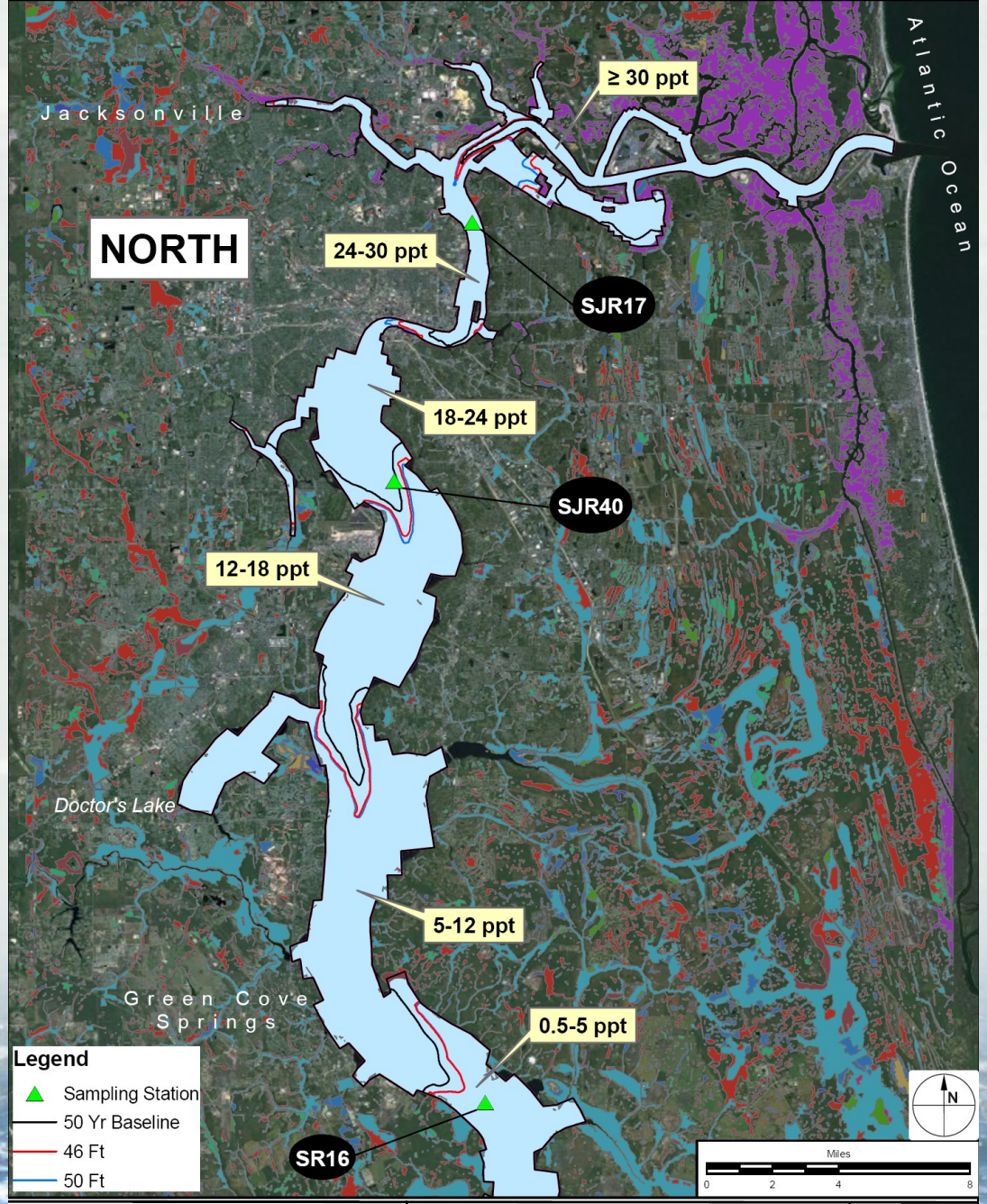
PROJECT	C2012-010
DRAWN BY	CAS
SHEET	
DATE	OCT 2012



Taylor Engineering Inc.
10151 Deerwood Park Blvd.
Bldg. 300, Suite 300
Jacksonville, FL 32256
CERTIFICATE OF AUTHORIZATION # 4815

Maximum Bottom Salinity
30 Day Moving Average
Baseline, 46 Ft and 50 Ft Channels
USACE Ecological Modeling for Jax Harbor Deepening

PROJECT	C2012-010
DRAWN BY	CAS
SHEET	
DATE	OCT 2012



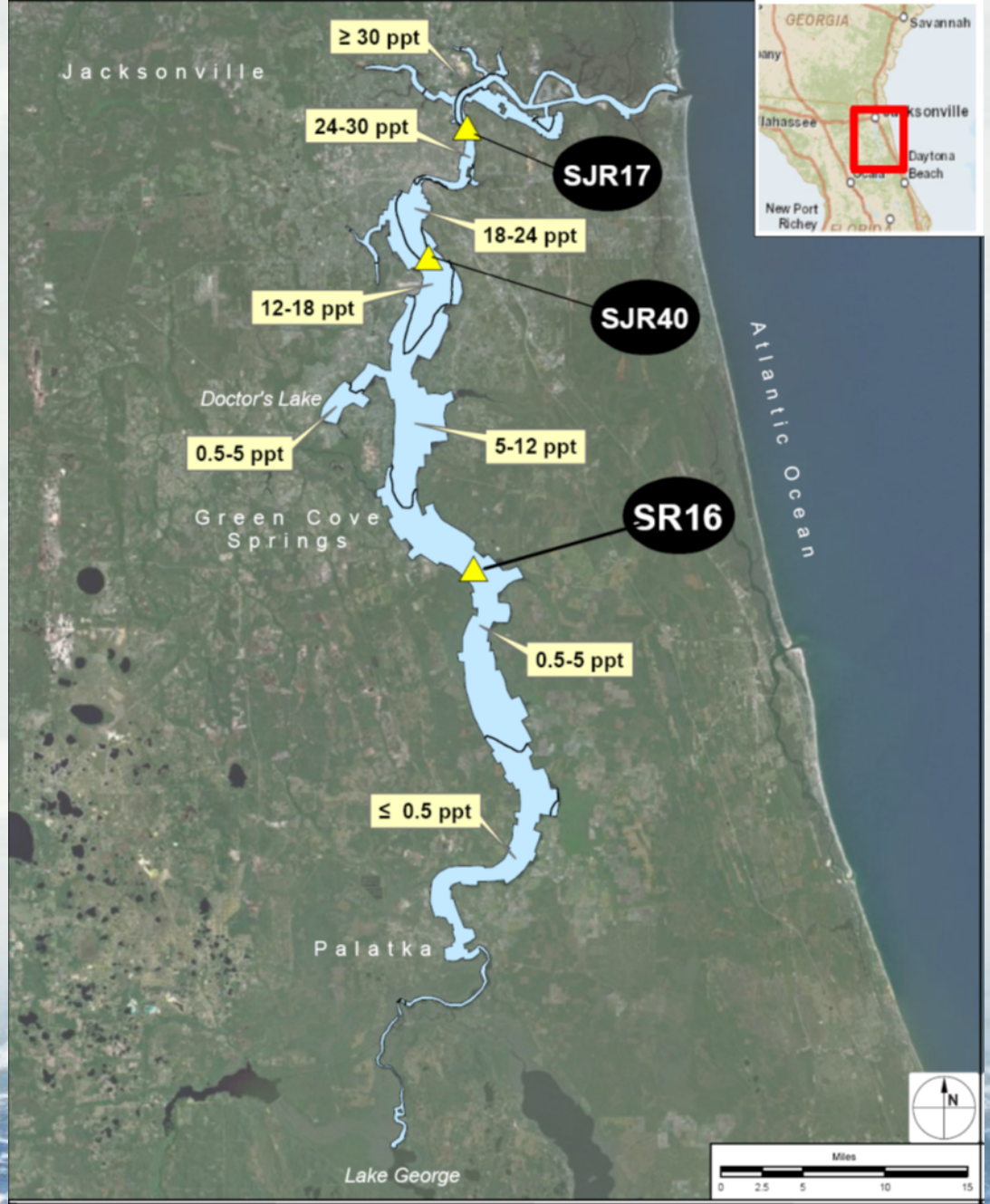
Taylor Engineering Inc.
10151 Deerwood Park Blvd.
Bldg. 300, Suite 300
Jacksonville, FL 32256
CERTIFICATE OF AUTHORIZATION # 4615

Maximum Water Salinity
30 Day Moving Average
50Yr Horizon: Baseline, 46 Ft and 50 Ft Channels
USACE Ecological Modeling for Jax Harbor Deepening

PROJECT	C2012-010
DRAWN BY	CAS
SHEET	
DATE	OCT 2012

BENTHIC MACROINVERTEBRATE (BMI) MODEL
PDFA – Moving Average Maximum Bottom Salinities

- **P**artial **D**uration **F**requency **A**nalysis (PDFA)
  - Dataset – Maximum Bottom Salinity Day for 6-yr simulation
  - PDFA calculates the number and duration of salinity events exceeding specific salinities
  - Allows comparison of salinity events occurring in different project alternatives
    - Baseline salinity events are compared to each alternative
  - PDFA developed at three locations associated with SJRWMD sampling

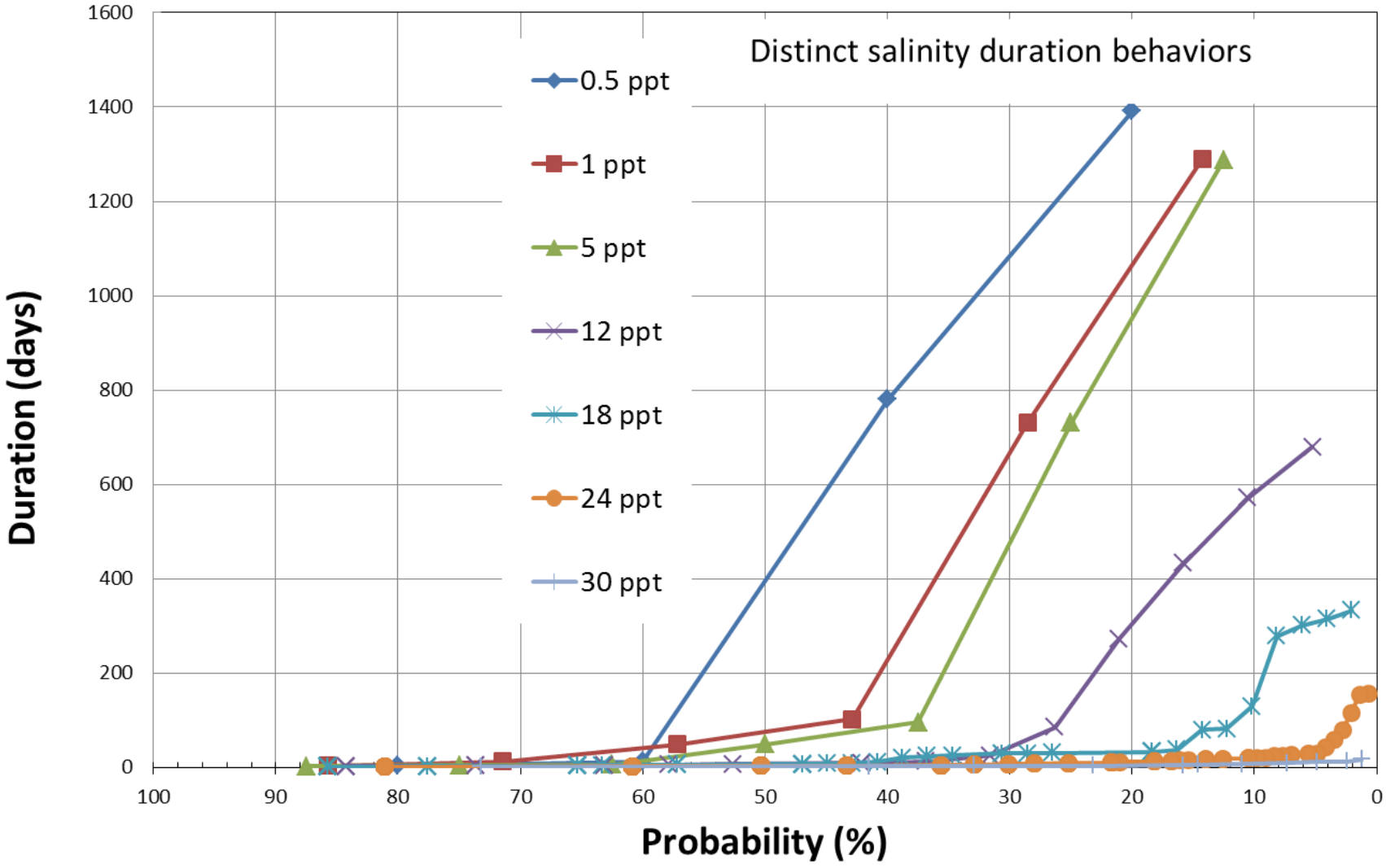


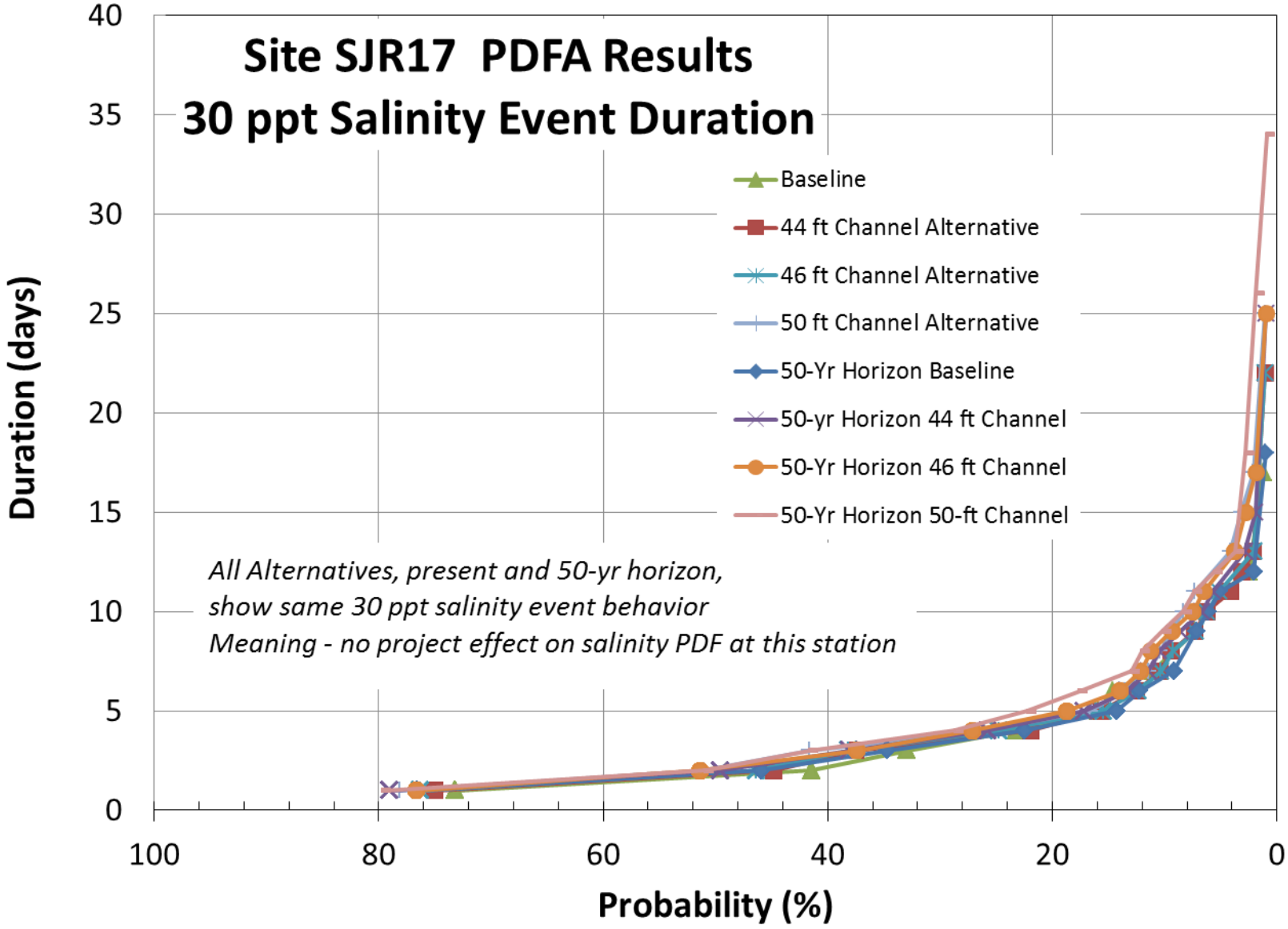
Taylor Engineering Inc.
10151 Deerwood Park Blvd.
Bldg. 300, Suite 300
Jacksonville, FL 32256
CERTIFICATE OF AUTHORIZATION # 4615

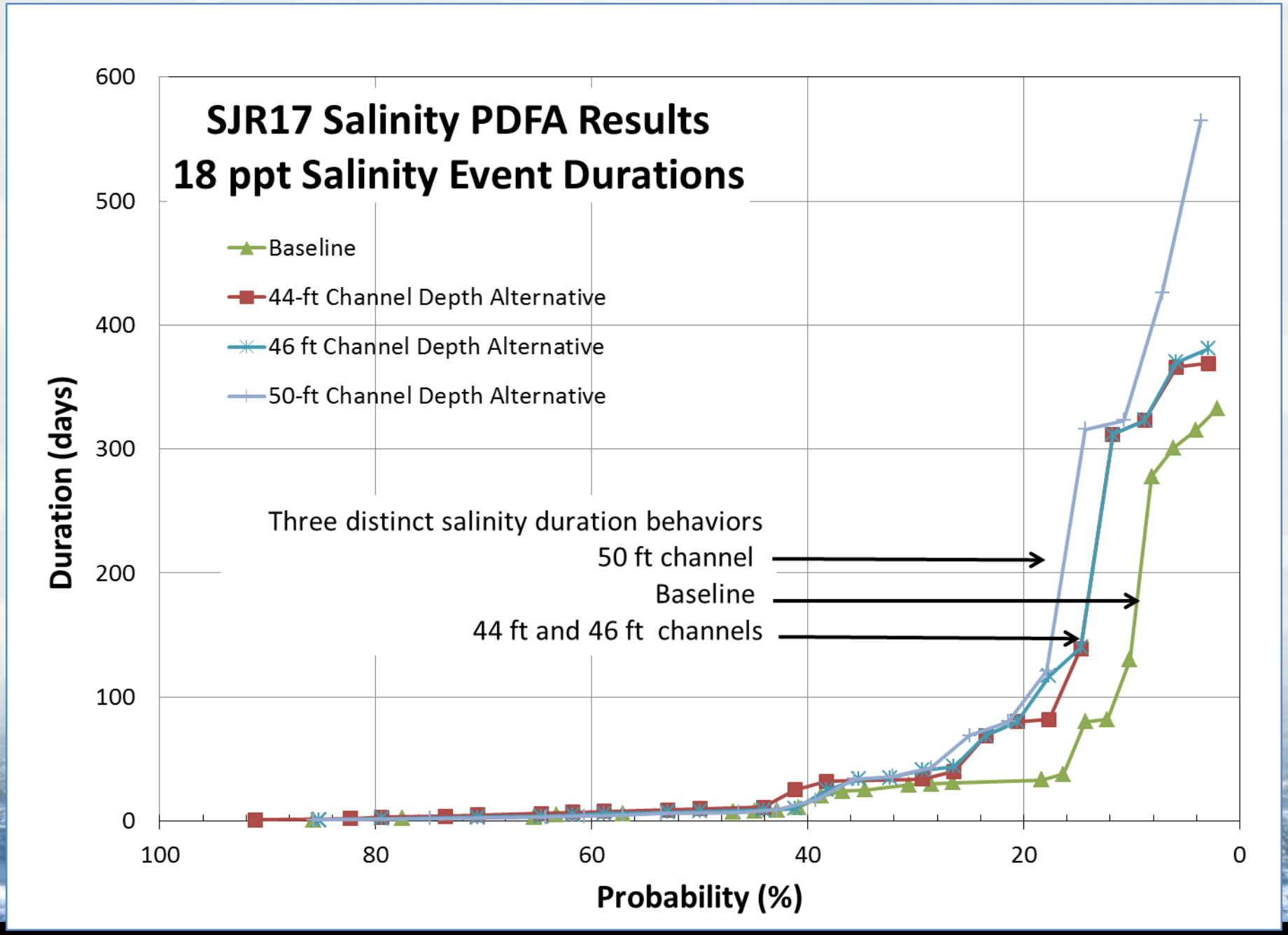
Maximum Bottom Salinity
30 Day Moving Average
Existing Condition (Baseline)
USACE Ecological Modeling for Jax Harbor Deepening

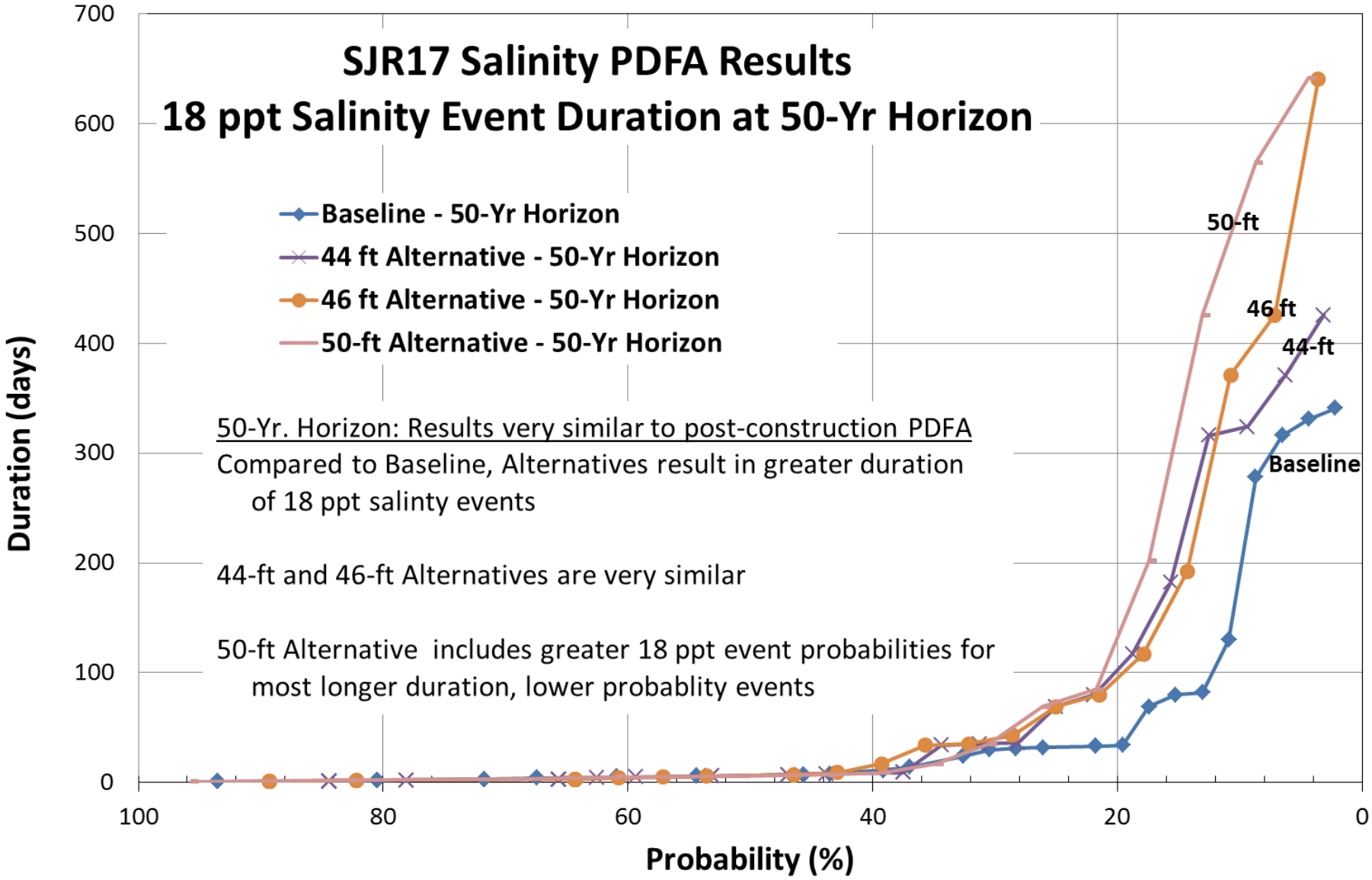
PROJECT	C2012-010
DRAWN BY	CAS
SHEET	
DATE	OCT 2012

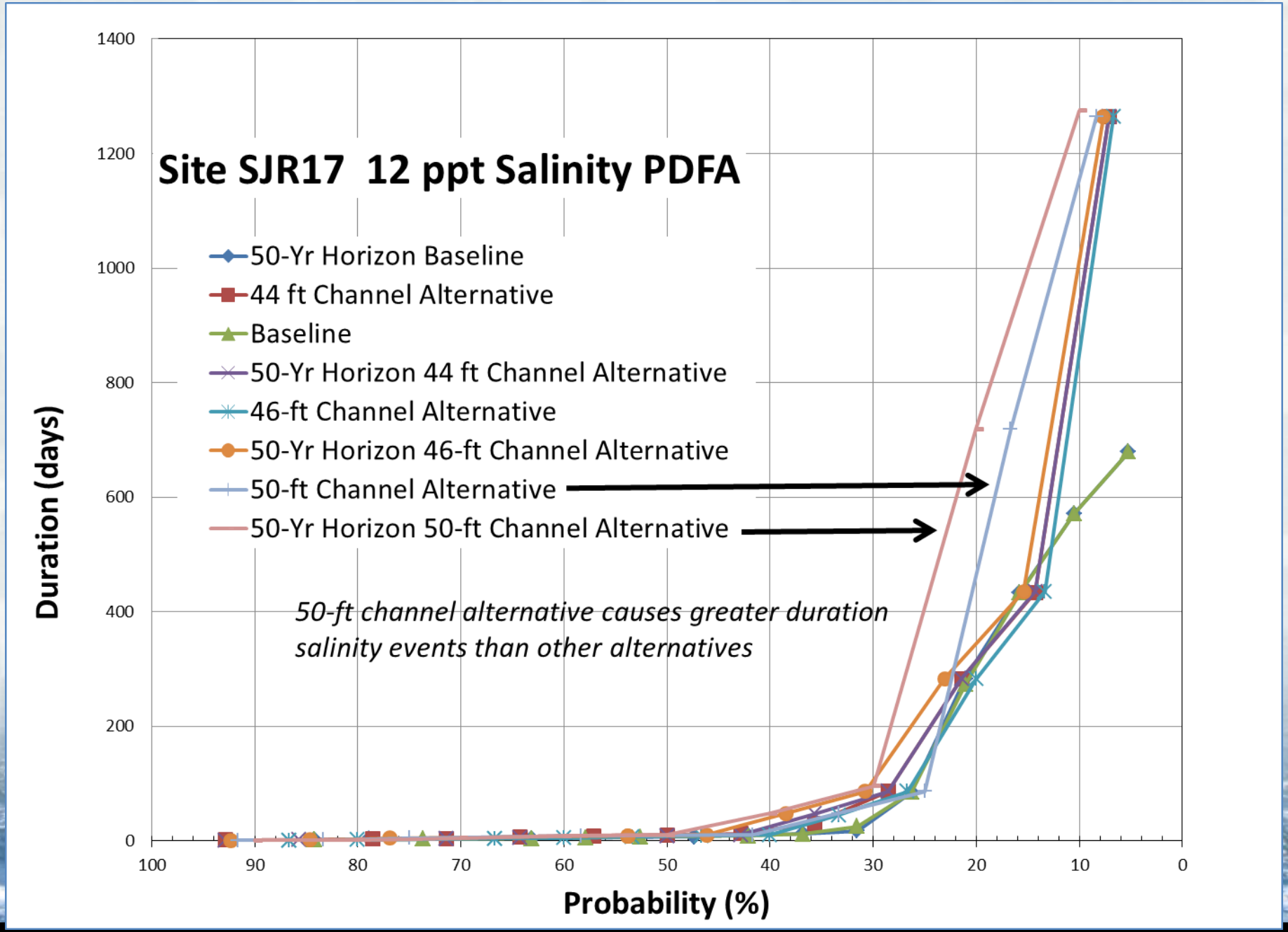
Max Bottom Salinity PDFA at Site SJR17
Existing Conditions: No Action Alternative
(CFO_B95_SL0_SJR17)

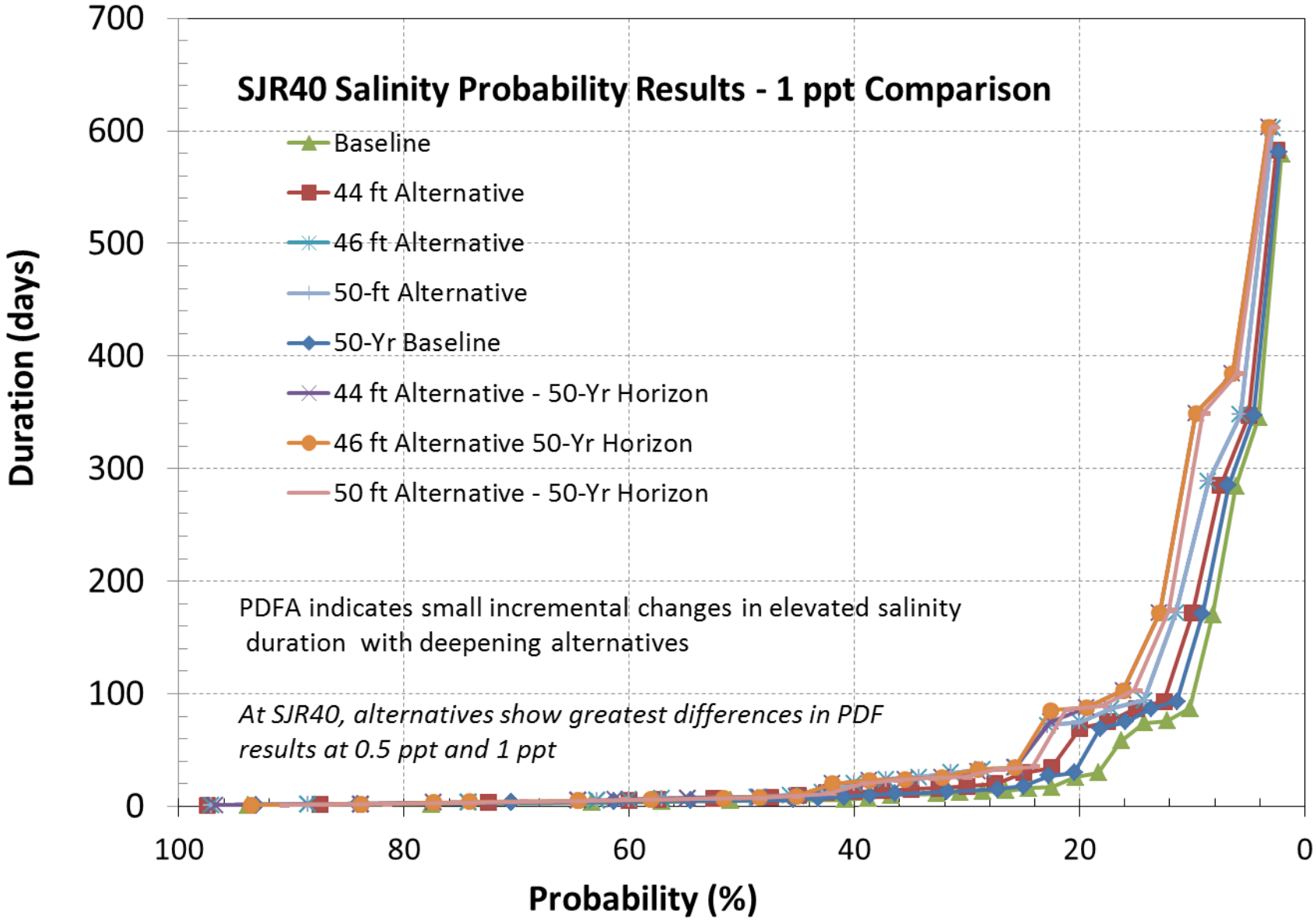


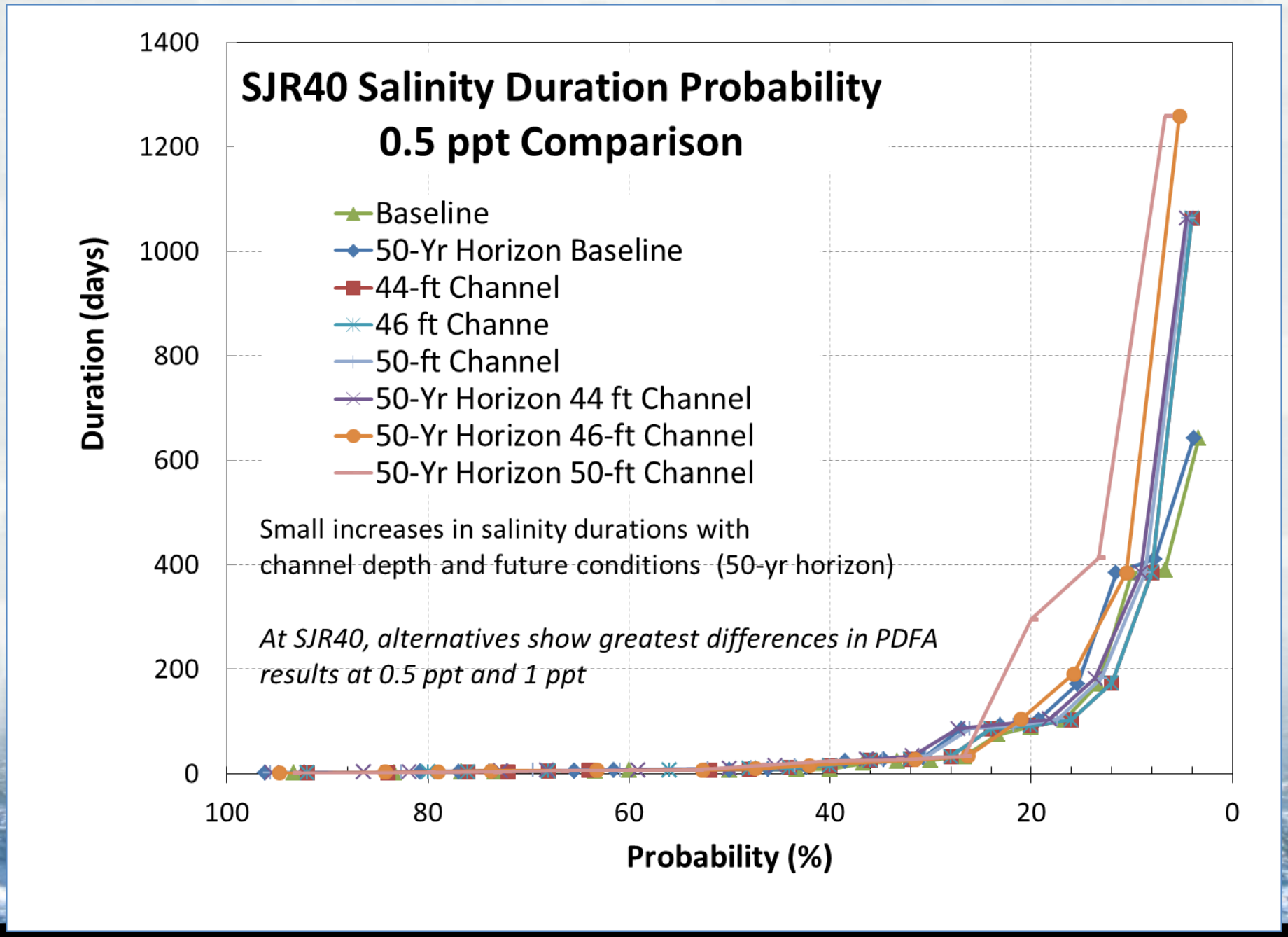

Site SJR17 PDFA Results
30 ppt Salinity Event Duration
Duration (days)
40
35
30
25
20
15
10
5
0
100
80
60
40
20
0
Probability (%)
Baseline
44 ft Channel Alternative
46 ft Channel Alternative
50 ft Channel Alternative
50-Yr Horizon Baseline
50-yr Horizon 44 ft Channel
50-Yr Horizon 46 ft Channel
50-Yr Horizon 50-ft Channel
All Alternatives, present and 50-yr horizon,
show same 30 ppt salinity event behavior
Meaning - no project effect on salinity PDF at this station

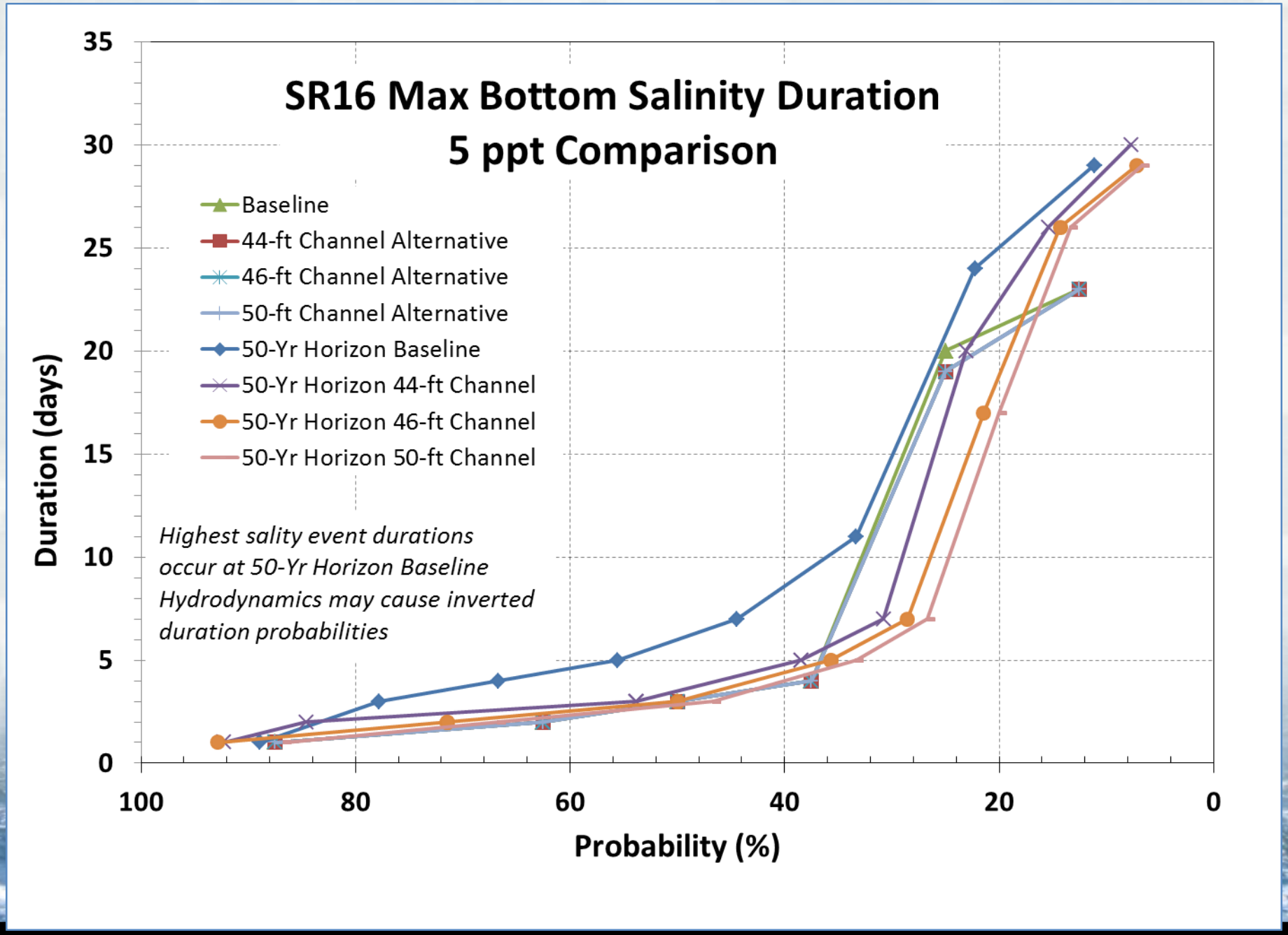

SJR17 Salinity PDFA Results
18 ppt Salinity Event Durations
Baseline
44-ft Channel Depth Alternative
46 ft Channel Depth Alternative
50-ft Channel Depth Alternative
Three distinct salinity duration behaviors
50 ft channel
Baseline
44 ft and 46 ft channels
Duration (days)
600
500
400
300
200
100
0
100
80
60
40
20
0
Probability (%)

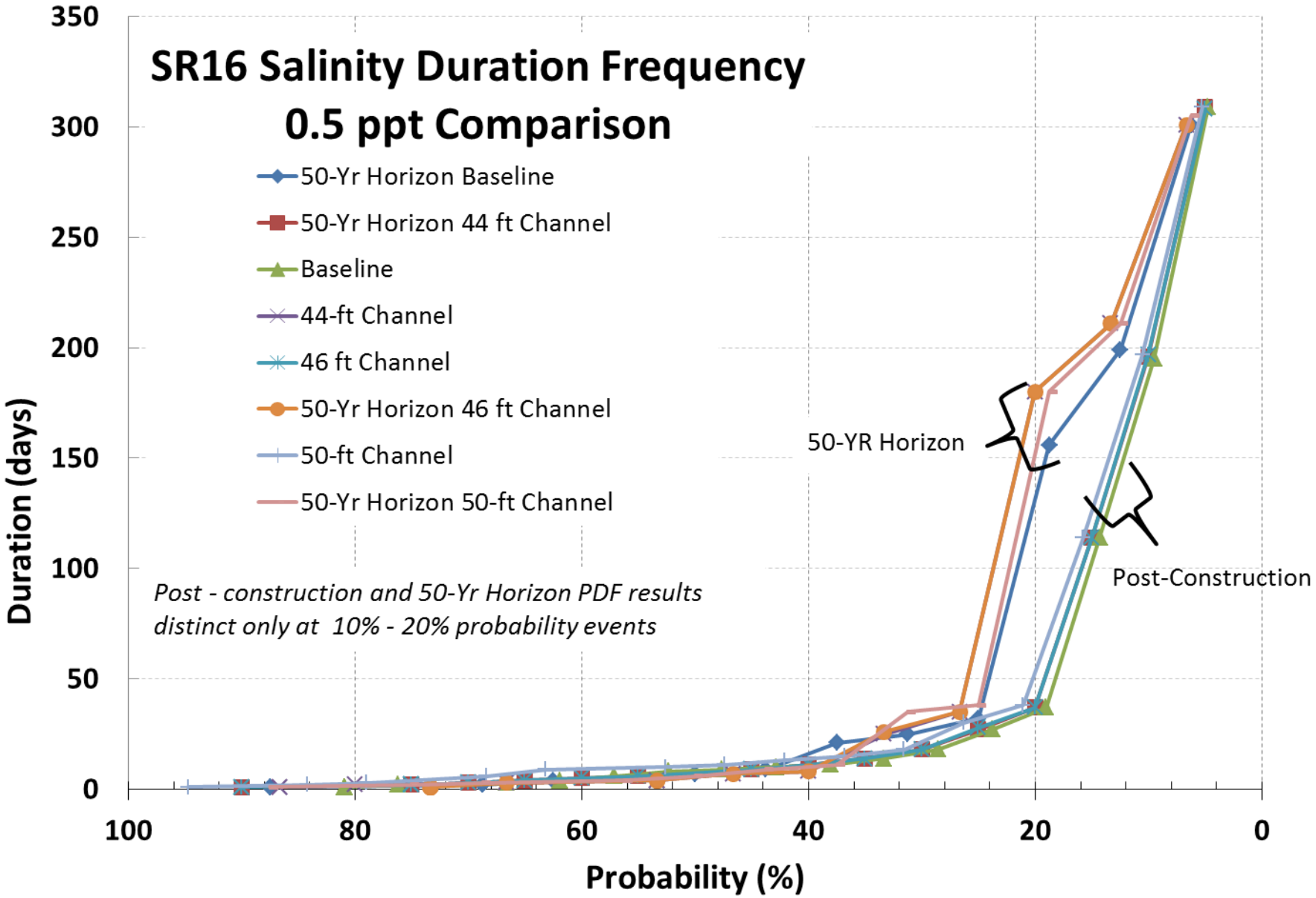

SJR17 Salinity PDFA Results
18 ppt Salinity Event Duration at 50-Yr Horizon
Baseline - 50-Yr Horizon
44 ft Alternative - 50-Yr Horizon
46 ft Alternative - 50-Yr Horizon
50-ft Alternative - 50-Yr Horizon
50-Yr. Horizon: Results very similar to post-construction PDFA
Compared to Baseline, Alternatives result in greater duration of 18 ppt salinty events
44-ft and 46-ft Alternatives are very similar
50-ft Alternative includes greater 18 ppt event probabilities for most longer duration, lower probablity events
50-ft
46 ft
44-ft
Baseline
Duration (days)
Probability (%)
700
600
500
400
300
200
100
0
100
80
60
40
20
0


Site SJR17 12 ppt Salinity PDFA
50-Yr Horizon Baseline
44 ft Channel Alternative
Baseline
50-Yr Horizon 44 ft Channel Alternative
46-ft Channel Alternative
50-Yr Horizon 46-ft Channel Alternative
50-ft Channel Alternative
50-Yr Horizon 50-ft Channel Alternative
50-ft channel alternative causes greater duration salinity events than other alternatives
Duration (days)
Probability (%)
1400
1200
1000
800
600
400
200
0
100
90
80
70
60
50
40
30
20
10
0


SJR40 Salinity Probability Results - 1 ppt Comparison
Baseline
44 ft Alternative
46 ft Alternative
50-ft Alternative
50-Yr Baseline
44 ft Alternative - 50-Yr Horizon
46 ft Alternative 50-Yr Horizon
50 ft Alternative - 50-Yr Horizon
PDFA indicates small incremental changes in elevated salinity duration with deepening alternatives
At SJR40, alternatives show greatest differences in PDF results at 0.5 ppt and 1 ppt
Duration (days)
700
600
500
400
300
200
100
0
100
80
60
40
20
0
Probability (%)


SJR40 Salinity Duration Probability
0.5 ppt Comparison
Baseline
50-Yr Horizon Baseline
44-ft Channel
46 ft Channe
50-ft Channel
50-Yr Horizon 44 ft Channel
50-Yr Horizon 46-ft Channel
50-Yr Horizon 50-ft Channel
Small increases in salinity durations with channel depth and future conditions (50-yr horizon)
At SJR40, alternatives show greatest differences in PDFA results at 0.5 ppt and 1 ppt
Duration (days)
1400
1200
1000
800
600
400
200
0
100
80
60
40
20
0
Probability (%)


SR16 Max Bottom Salinity Duration
5 ppt Comparison
Baseline
44-ft Channel Alternative
46-ft Channel Alternative
50-ft Channel Alternative
50-Yr Horizon Baseline
50-Yr Horizon 44-ft Channel
50-Yr Horizon 46-ft Channel
50-Yr Horizon 50-ft Channel
Highest sality event durations occur at 50-Yr Horizon Baseline Hydrodynamics may cause inverted duration probabilities
Duration (days)
35
30
25
20
15
10
5
0
100
80
60
40
20
0
Probability (%)


SR16 Salinity Duration Frequency
0.5 ppt Comparison
50-Yr Horizon Baseline
50-Yr Horizon 44 ft Channel
Baseline
44-ft Channel
46 ft Channel
50-Yr Horizon 46 ft Channel
50-ft Channel
50-Yr Horizon 50-ft Channel
Post - construction and 50-Yr Horizon PDF results
distinct only at 10% - 20% probability events
50-YR Horizon
Post-Construction
Duration (days)
350
300
250
200
150
100
50
0
100
80
60
40
20
0
Probability (%)

FISH MODEL

Evaluation Topic

- Fish abundance

Effects Drivers

- Salinity
- SAV cover

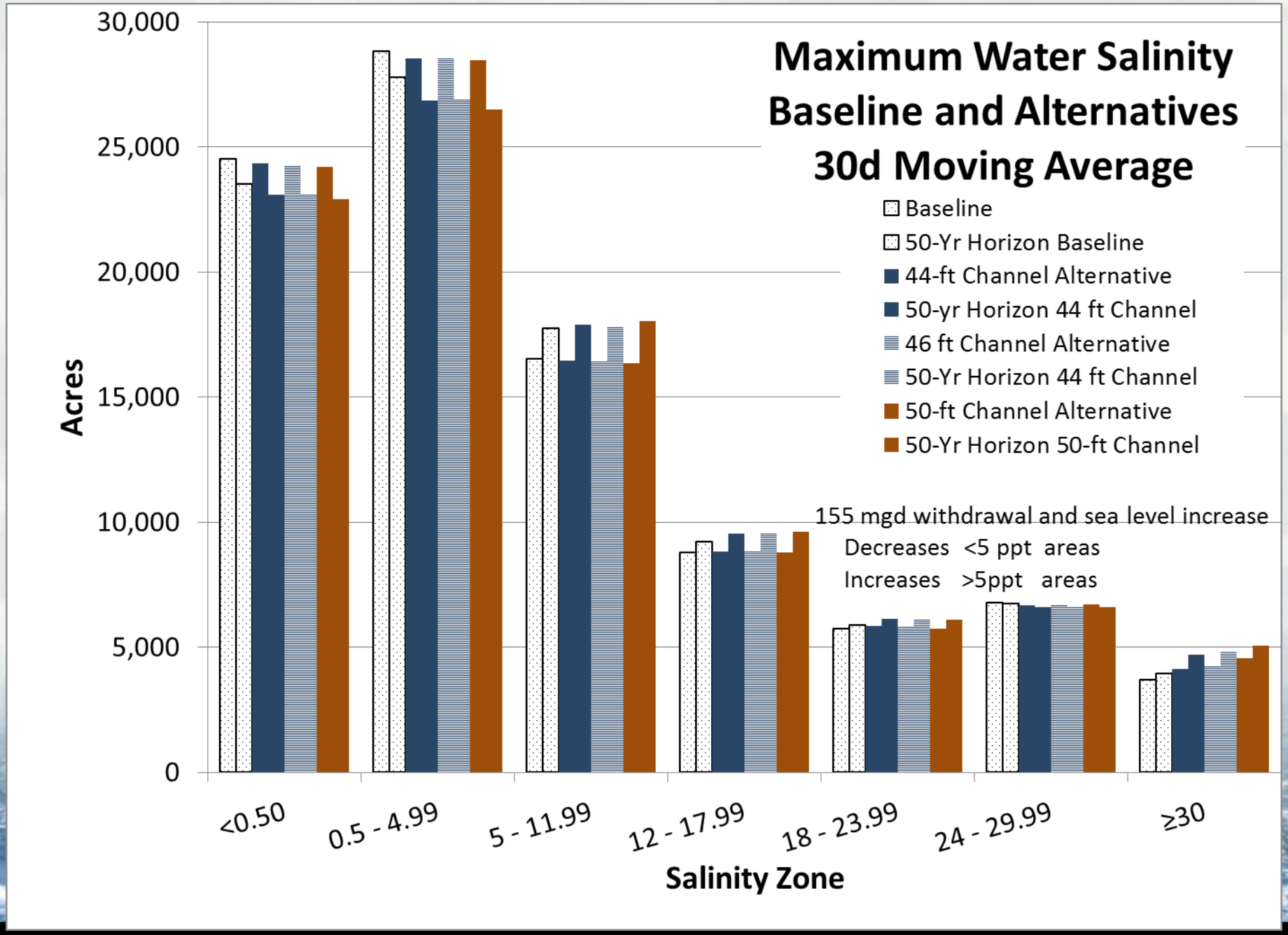
Evaluation Methods

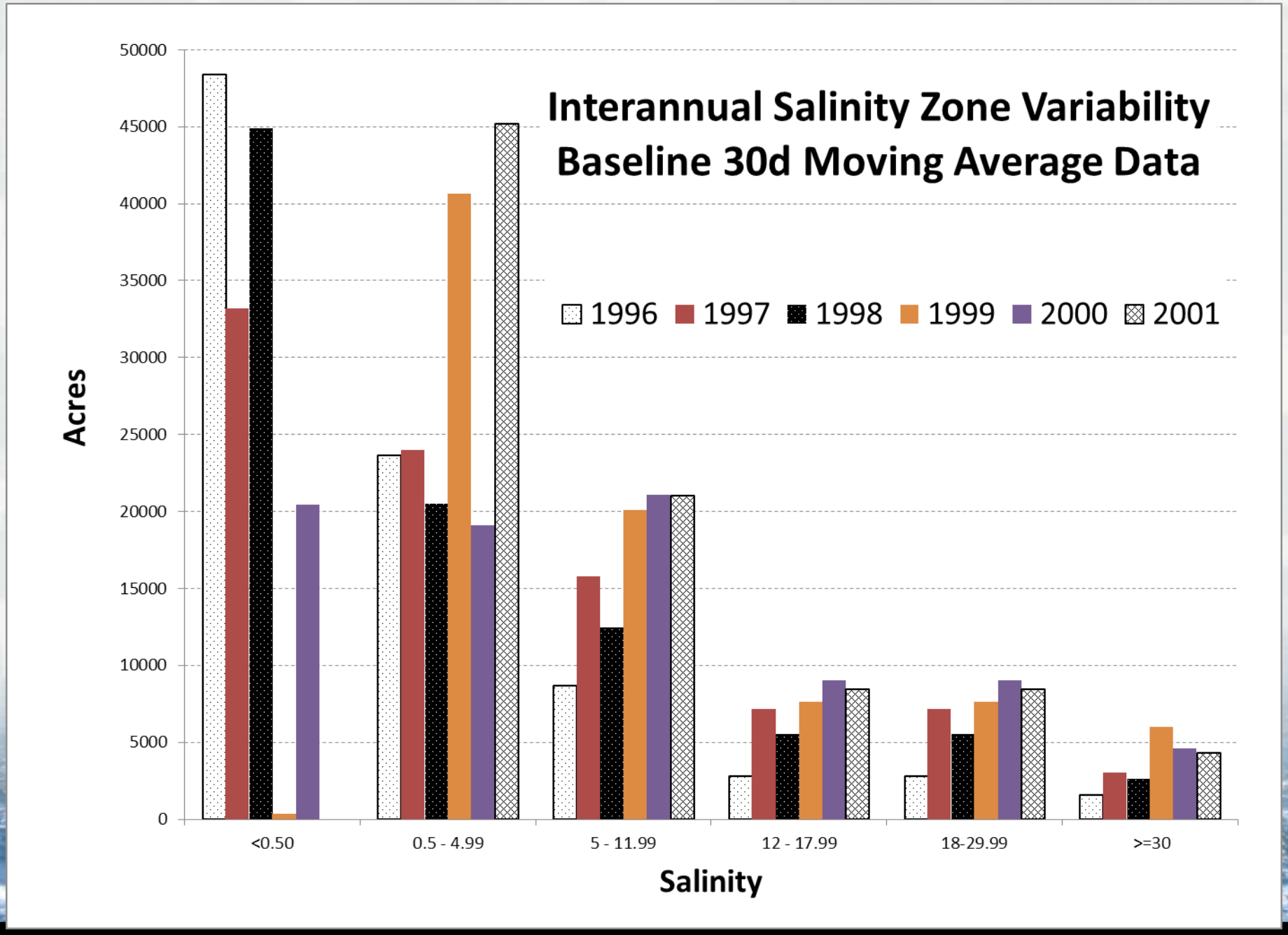
- Changes in area of each salinity category
- Changes in SAV cover

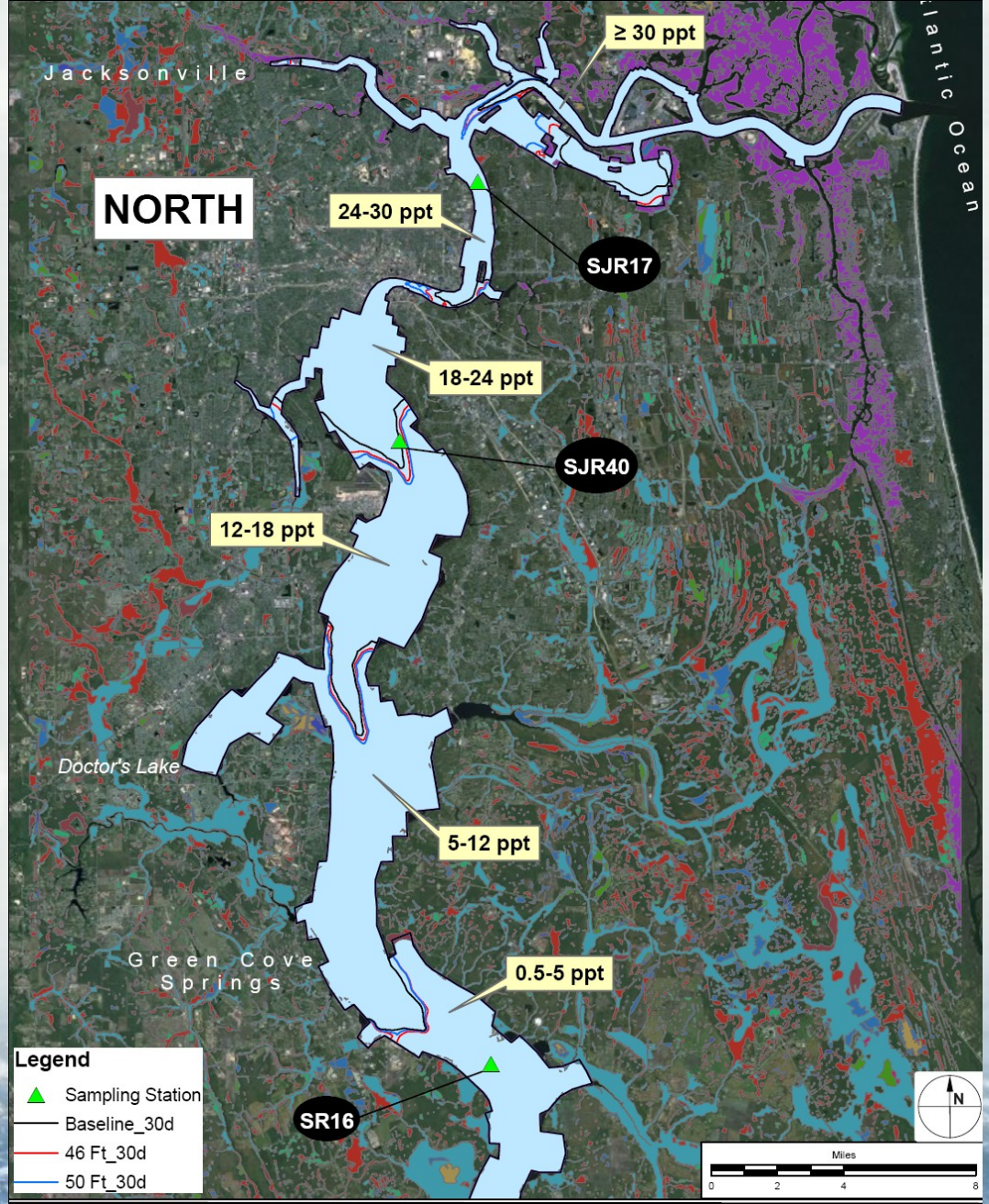
FISH MODEL

Results

- Lower salinity waters (5ppt and less) dominate the study area.
- Little change in area (acres) associated with each salinity range
- Project alternatives result in only minor upstream-downstream shifts in salinity zones
- Inter-annual salinity zone changes far exceed changes associated with comparison of baseline and action alternatives


Maximum Water Salinity
Baseline and Alternatives
30d Moving Average
Baseline
50-Yr Horizon Baseline
44-ft Channel Alternative
50-yr Horizon 44 ft Channel
46 ft Channel Alternative
50-Yr Horizon 44 ft Channel
50-ft Channel Alternative
50-Yr Horizon 50-ft Channel
155 mgd withdrawal and sea level increase
Decreases <5 ppt areas
Increases >5ppt areas
Acres
30,000
25,000
20,000
15,000
10,000
5,000
0
<0.50
0.5 - 4.99
5 - 11.99
12 - 17.99
18 - 23.99
24 - 29.99
≥30
Salinity Zone

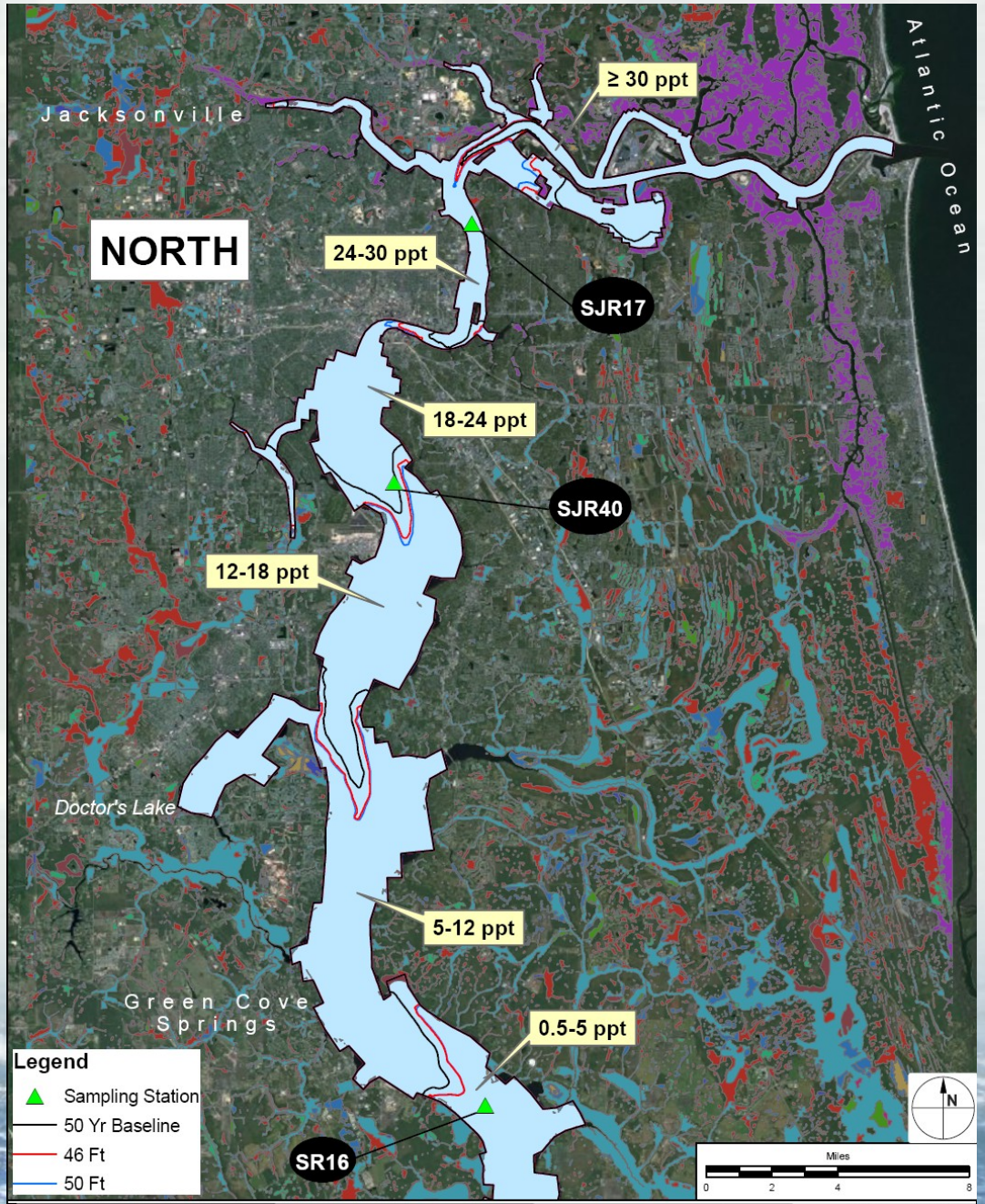

Interannual Salinity Zone Variability
Baseline 30d Moving Average Data
1996
1997
1998
1999
2000
2001
Acres
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
<0.50
0.5 - 4.99
5 - 11.99
12 - 17.99
18-29.99
>=30
Salinity



Taylor Engineering Inc.
10151 Deerwood Park Blvd.
Bldg. 300, Suite 300
Jacksonville, FL 32256
CERTIFICATE OF AUTHORIZATION # 4815

Maximum Water Salinity
30 Day Moving Average
Baseline, 46 Ft and 50 Ft Channels
USACE Ecological Modeling for Jax Harbor Deepening

PROJECT	C2012-010
DRAWN BY	CAS
SHEET	
DATE	OCT 2012



Taylor Engineering Inc.
10151 Deerwood Park Blvd.
Bldg. 300, Suite 300
Jacksonville, FL 32256
CERTIFICATE OF AUTHORIZATION # 4815

Maximum Water Salinity
30 Day Moving Average
50Yr Horizon: Baseline, 46 Ft and 50 Ft Channels
USACE Ecological Modeling for Jax Harbor Deepening

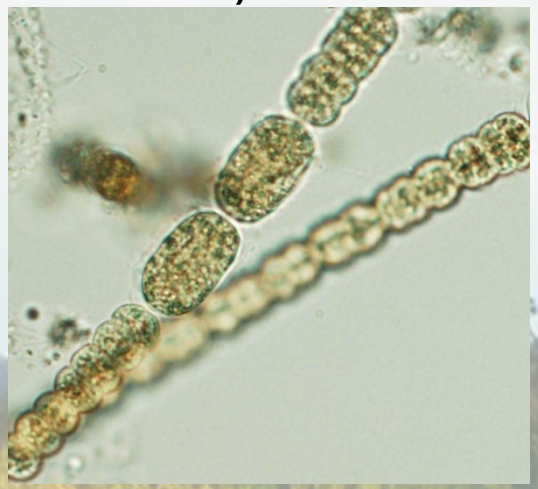
PROJECT	C2012-010
DRAWN BY	CAS
SHEET	
DATE	OCT 2012

PLANKTON MODEL

Evaluation Topics (algal bloom metrics)

- Marine algal blooms
- Freshwater bloom
- Nitrogen (N) loading via N_2-fixat
  (chlorophyll-a maximum/dissolved oxygen minimum)

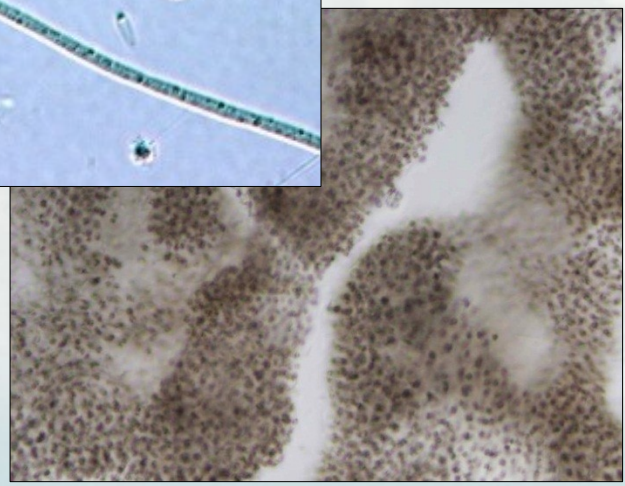
  magnitude
- Freshwater bloom duration



PLANKTON MODEL

Evaluation Method

- Regression models
- Water age measures are independent variables



PLANKTON MODEL

Results

- Regressions do not produce reasonable results with water age values from our EFDC model
- Regression equations are likely highly dependent on results from specific version of EFDC model

Alternate Evaluation

- Qualitative review of water age and plankton metric relationships
- General trends and magnitude of change in water age variables among project alternatives

JACKSONVILLE HARBOR DEEPENING STUDY WEBSITE

WWW.SAJ.USACE.ARMY.MIL